MAY 1960

Heating Piping & Air Conditioning

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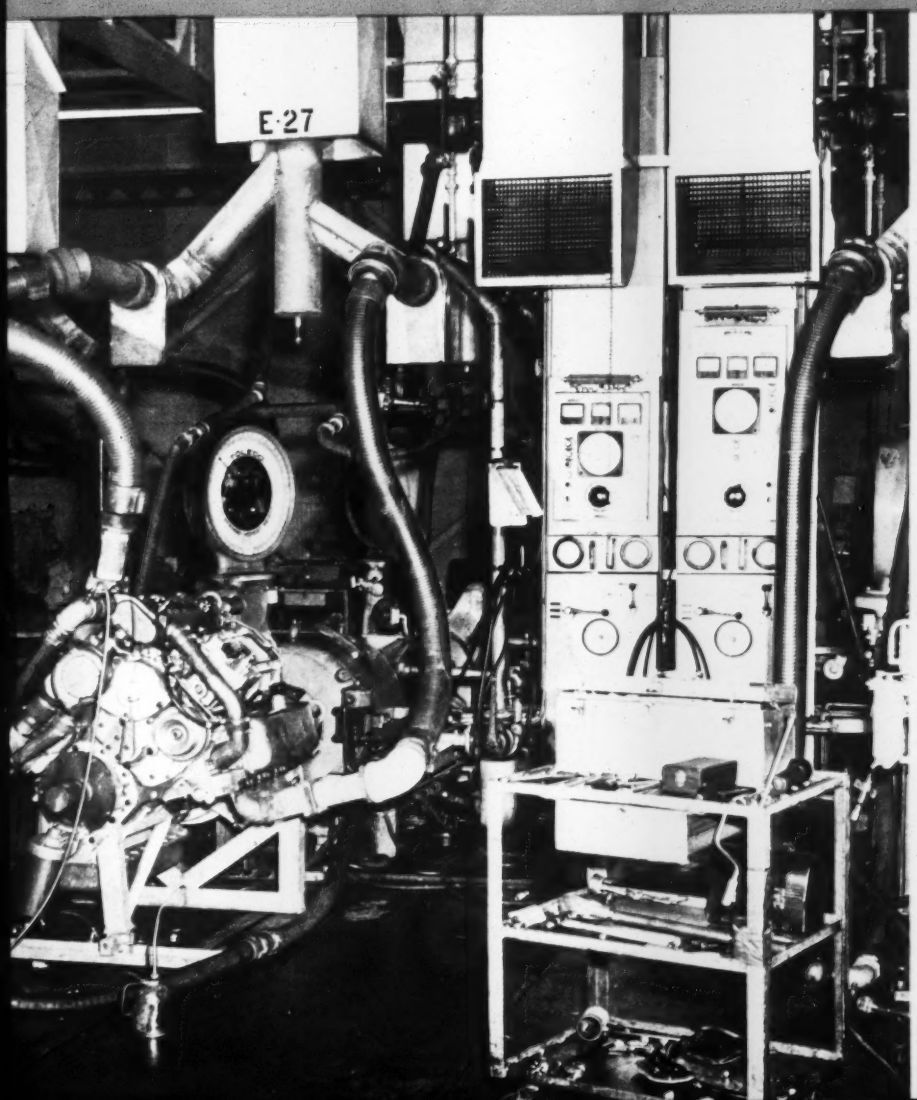
. . . for Consulting Engineers • Mechanical (Heating, Piping, and Air Conditioning) Contractors • Engineers with Plants and Big Buildings



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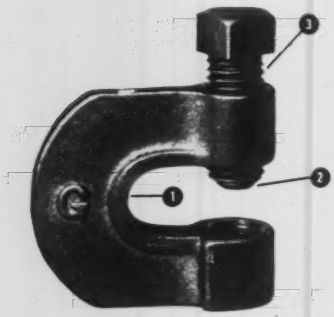
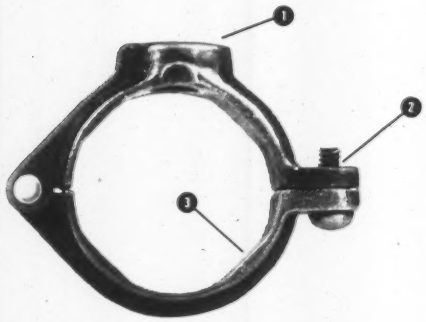
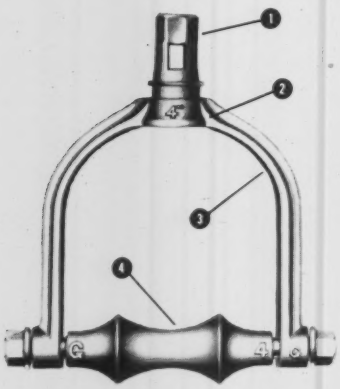


GRINNELL C-CLAMP, FIG. 88 — 1 Ribbed, malleable iron casting, for extra strength **2** Hardened steel, cup-point set screw for good "grip" on beam **3** Full thread engagement – casting is drilled and tapped for rod and set screw



GRINNELL EXTENSION SPLIT RING, FIG. 138 — 1 Nipple engaging thick section of malleable iron gives rigidity for support from above, below or from wall **2** Tapped to take screw. No nut to lose **3** Special ring contour holds pipe or tubing firmly



GRINNELL ADJUSTABLE SWIVEL PIPE ROLL, FIG. 174 — 1 Swivel shank permits adjustment without elaborate support **2** Locking device prevents accidental adjustment change; no lock nut required **3** Ribbed design in malleable iron for better strength, lightness, appearance **4** Easy installation; maximum adjustment

GRINNELL CB CONCRETE INSERT, FIG. 282 — 1 One body size accommodates several sizes of rods **2** Slot takes reinforcing rods to assure maximum load rating **3** One-piece body prevents concrete seepage **4** Teeth on insert and nut hold rod firmly in place **5** Homogeneous composition of malleable iron throughout

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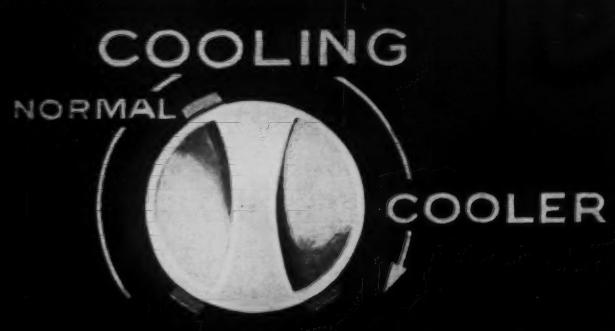

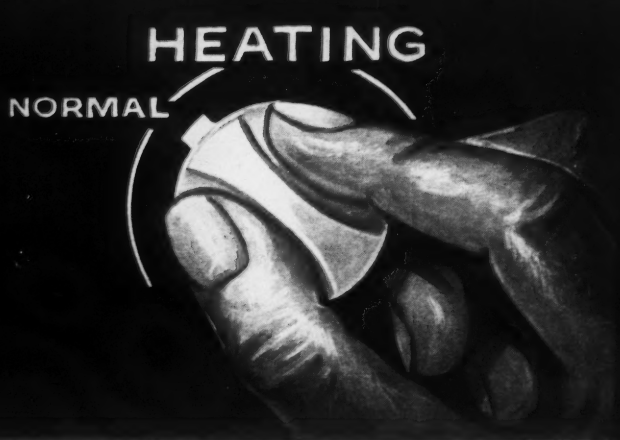

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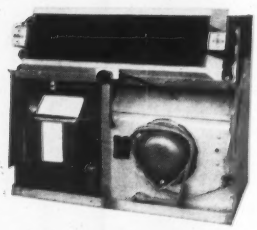

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VOL. 32, NO. 5 MAY 1960

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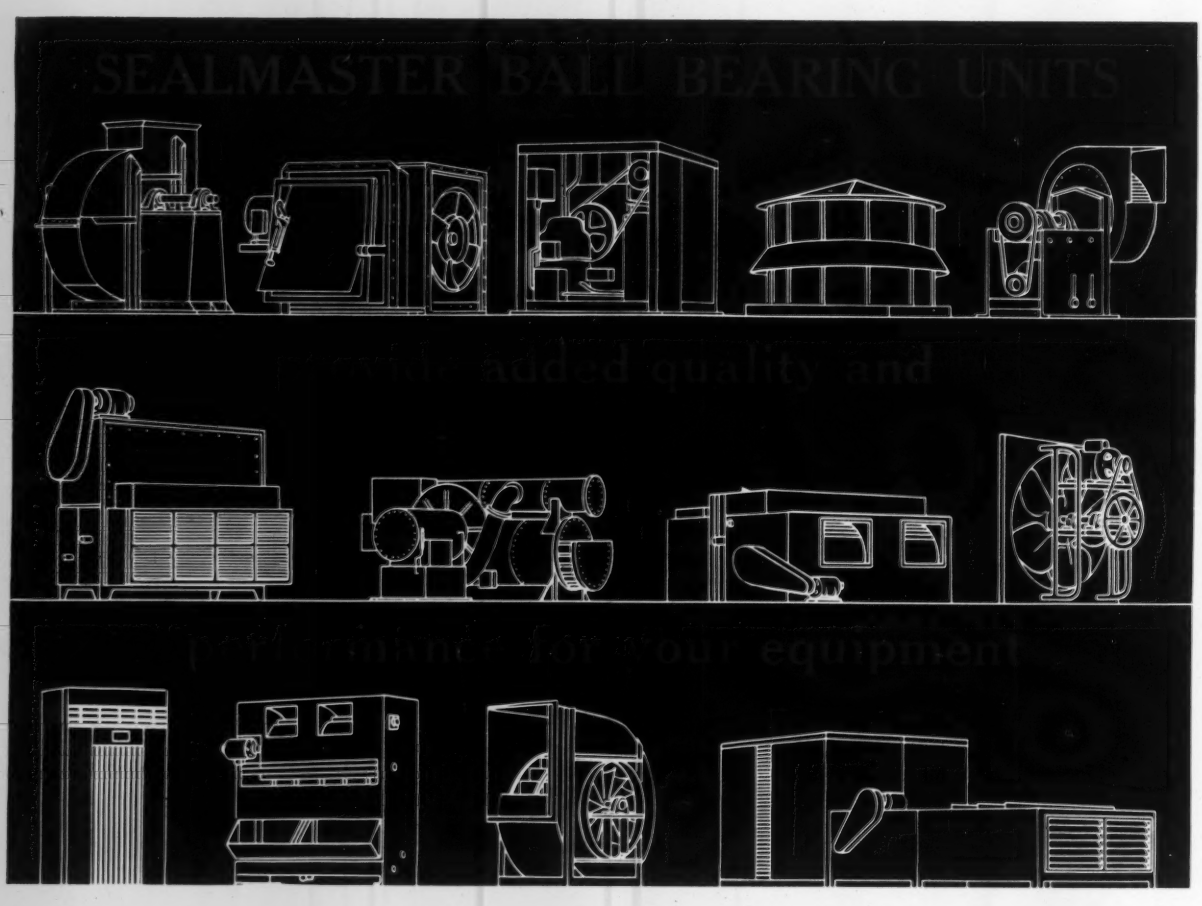

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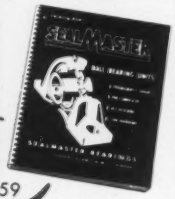

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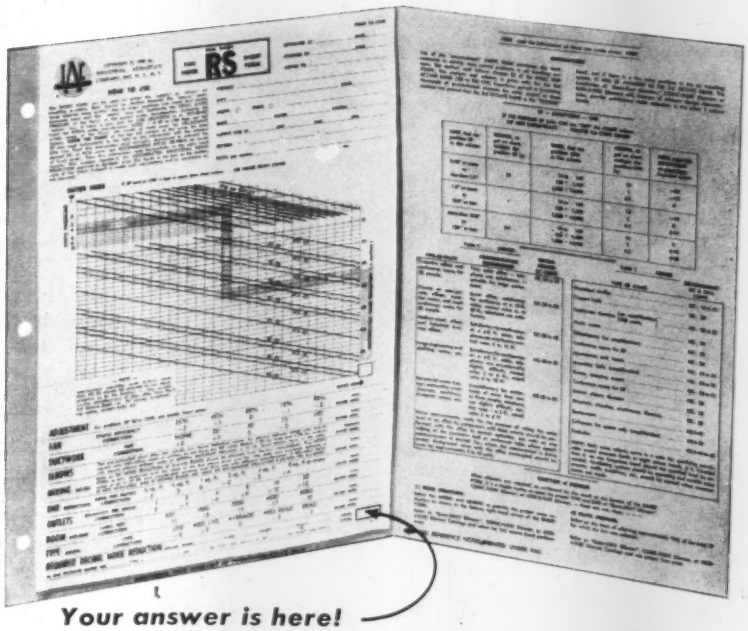

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How *Imaginative Engineering* Put
Taming Chicago's

John Dolio (right) in front of Powers Graph-O-Matic Control Panel with E. S. Anderson, engineer for the Illinois Psychiatric Institute.

The unusual temperature requirements specified for the new Illinois Psychiatric Institute presented an extraordinary challenge for John Dolio & Associates. This Chicago engineering firm was asked to provide an absolutely uniform temperature throughout the 11-story, T-shaped building. Because temperature variations cause extreme discomfort —even pain—to mental patients, the system had to be accurate, foolproof and automatic. Because Chicago temperatures rise or fall to extremes within hours—sometimes minutes —the system had to be capable of sensing the changing weather picture outside and automatically and simultaneously reacting inside.

The resulting design provides all the answers . . . in a Powers pneumatic control system that operates automatically 24 hours a day—every day—at a bare minimum of cost; a system that compensates instantly for sudden outdoor temperature changes; a system that can be checked and controlled by one man.

The result is a functional system of control where practical engineering principles were combined by the Dolio firm with a strong helping of ingenuity in order to whip some of the more unusual problems. For example, since chilled water was to circulate through ceiling heating-cooling panels, a safeguard against condensation was necessary. The engineers solved this problem with a series of dew point controls mounted at various locations in the ceilings. Thus, "controls on a control" prevent water temperature from falling to the point at which condensation could occur.

Phil Derrig, Chief Mechanical Engineer of the Dolio firm, inspects one of the dew point controls specially designed to prevent condensation of cold water in the ceiling heating-cooling panels.

Powers Temperature Control To Work Weather At Illinois Psychiatric Institute

Illinois Psychiatric Institute
Chicago, Ill.

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Louis H. Gerding
Architects:
Shaw, Metz & Associates, Chicago
Associate Architects and Engineers:
Fugard, Burt, Wilkinson and Orth
Consulting Engineers:
John Dolio & Associates, Chicago
Heating, Air Conditioning Contractor:
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Ventilation: Zack Co., Chicago

JOB DETAILS

The system encompasses 12 temperature zones, each designed to operate independently in relation to individual zone exposure problems. Ten zones utilize ceiling heating and cooling panels at which hot and chilled water circulate from zone exchangers. Three-way control valves for the water are modulated by pneumatic thermostats in various rooms. Two zones — auditorium and stairwell — have only heat exchangers (the auditorium is supplied with individual conditioned air).

Master outdoor controls sense the changes in temperature outdoors and instantly reset submaster pneumatic thermostats at the zone exchangers. These indoor-outdoor controls are engineered for foolproof maintenance of uniform zone temperatures.

A central control board, the heart of the Dolio design, monitors the complete heating, cooling and ventilating system. The building engineer alone can instantly check 170 control points by merely referring to the Powers Graph-O-Matic Control Panel.

Temperature controls are inaccessible to patients. All controls in the corridors are wall-mounted and cabinet-enclosed; temperature sensors are mounted in ceiling exhaust ducts.

Easy servicing and low maintenance are two big reasons why a pneumatic system of control was specified by this engineering firm. Efficiency at low cost is characteristic of this type of control — as it is with the Powers pneumatic system installed here.

Safety and comfort for patients is provided for throughout. For example, in hydrotherapy, in showers, in sitz baths, etc., Powers Hydroguard® thermostatic water controls prevent scalding and eliminate dangerous water temperature fluctuations.

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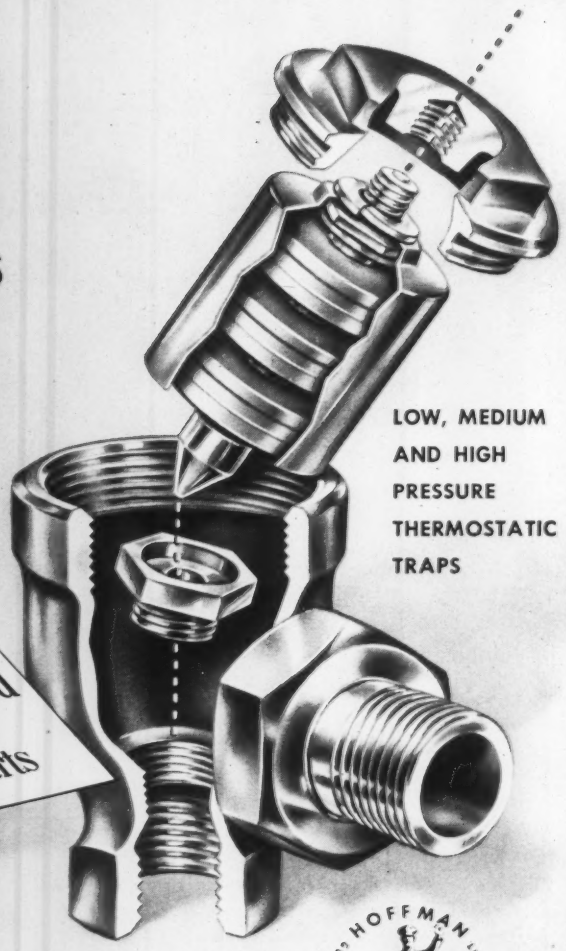

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LETTER FROM THE EDITOR

May 1960

Dear Reader:

The latest industrial environment thinking is reflected in the unique installation in the new Detroit Diesel Engine plant which is discussed by Lester S. Ries on pages 99 through 104. High velocity air (1800 to 2000 fpm) is introduced in the worker areas through supply outlets 10 ft above the floor. In the multiple engine test areas, where 70 engines can be tested simultaneously, the system is particularly interesting. Three separate air duct systems are used in these areas. One is for removing the engine exhaust, one for supplying air to the space, and one for exhausting room air. These same systems can be changed from winter to summer operation with little effort. For summer operation the outdoor air is passed through an air washer to provide evaporative cooling. During the hot and humid summer of 1959, the test room temperature was maintained at a comfortable level by the combination of evaporative cooling and the high velocity air motion.

The corrosive effects of water quality at various temperatures and velocities on copper and copper alloys is presented by Dr. Obrecht and Dr. Quill on pages 105 through 112. Comprehensive tests were conducted at Michigan State University, and the results show that different temperatures, velocities, and water qualities all have different corrosive effects on copper tube. One of the findings showed that total corrosion appears to be the net result of temperature and velocity as well as the degree of softening and blending of the water. Many interesting photos were taken during the five-year study and some of these are shown to illustrate the results. Several design guides are given in this series of articles for the design of water piping systems in which copper tube is used.

Sam Lewis suggests on page 113 that the term "square foot" as a measure of heat should be outlawed. He points out the fallacies and inaccuracies encountered when using the term and how we all should use "Btu per hr" so as to be completely understood on this.

The new inert gas pilot plant for fabricating metals for space vehicles, missile nose cones, and rocket engines in Pennsylvania presented many interesting problems in building this "first-time-in-history" facility. How it was planned and designed is discussed on pages 114 through 116. To prevent the super high temperature refractory and reactive metals from reacting in the earth's atmosphere, the pilot plant, located within a larger building, is pressurized with 99.995 percent pure argon. Some of the problems that had to be solved in the design of this interesting installation were (a) providing safety for the men working in the no-oxygen atmosphere, (b) keeping the expensive argon gas from leaking out of the inert fabrication plant, and (c) maintaining atmospheric purity, despite frequent opening and closing of the personnel and equipment locks.

How does solar energy measure up as a heat source for a heat pump? Much interesting data are presented by Professor E. B. Penrod of the University of Kentucky and Mr. K. V. Prasanna in their article in answer to this question on pages 117 through 126. The authors have studied the performance of an installation in which the solar energy incident on a solar collector has been used as a heat pump source to supplement that stored in the earth. A collector and ground coil provided the evaporator load during the heating period. The soil adjacent to the ground coil served as a reservoir for temporarily storing excess solar energy collected during bright sunny days. Information on the relative cost of operation of the system is also included.

Why stainless steel piping systems perform as they do is explained by Arthur C. Wicker on page 127. He discusses the weldability of the three main series of stainless steel, and he describes eight principal kinds of corrosion which stainless steel can resist. He also outlines several service tests which furnish the best solution to individual corrosion problems. Mr. Wicker concludes this article with a discussion of the many applications of stainless steel process piping systems in industry and why they are used there.

After talking to a number of other heating, piping, and air conditioning engineers on the subject of direct throttling being a good method to control hot water heating systems, J. W. Scharres decided to write the article starting on page 132. This article is the result of many years of experience and the result of many conversations with other engineers on this subject. Mr. Scharres is convinced that the method advocated in his article is a good one, and he explains how it works and why it is so effective.

The annual directory of addresses of engineering societies and associations is presented this month as the HPAC Data Sheet on pages 135 and 136. I suggest that this be torn out and saved for your ready reference.

The operation of an induction unit air conditioning system can be improved by incorporating some minor changes in the piping and controls, according to Hem C. Gupta. He explains how these changes can improve the operation of these systems in his article on page 137. He also describes how this modified system will use the heat rejected into the condenser for providing reheat to the primary air. Therefore, when the outdoor air temperature is below 40 F, the use of the cooling tower will not be necessary, so the freeze-up problem is eliminated.

The design and installation of cryogenic piping systems is discussed by Dr. R. B. Jacobs in the HPAC Engineering Data File this month on pages 141 through 156. These systems must be designed to operate through a temperature range from room temperature down to almost absolute zero. Many of the fundamental considerations in piping system design apply to these systems for transporting liquefied gases. However, because of the low temperatures, the fluid flow characteristics are different from the usual, pumping equipment must necessarily be different, and the fabrication and installation of the piping systems require different techniques. Dr. Jacobs presents much data and a wealth of unique information on this subject. He also cites the precautions that should be observed for safe handling of the liquefied gases.

The principles of ventilating a large cafeteria kitchen are given in the Question of the month on pages 94 and 96. Some good tips are given on this subject in the answer to this question contributed by one of our readers.

Bob Roose

Editor, HEATING, PIPING & AIR CONDITIONING

20,000,000 cubic feet in New York's new 60-story Chase Manhattan Bank will be air-conditioned and heated with the help of some 1,500 tons of Bethlehem Steel Pipe

Beth-Co-Weld to 4-in., nom., and
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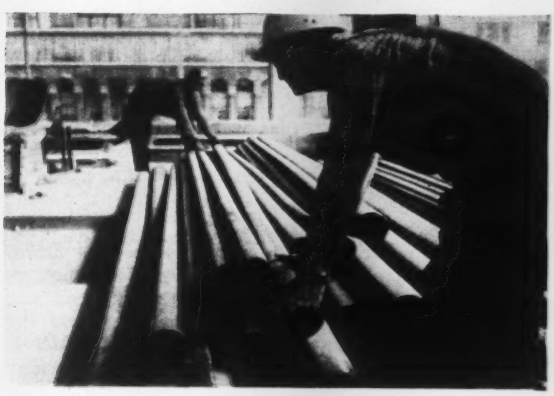
Mechanical Contractors: Raisler Corp. and Kerby Saunders, Inc.—A joint venture.
Pipe Jobber: Chas. F. Guyon, Inc.
Mechanical Engineers: Jaros, Baum & Bolles.



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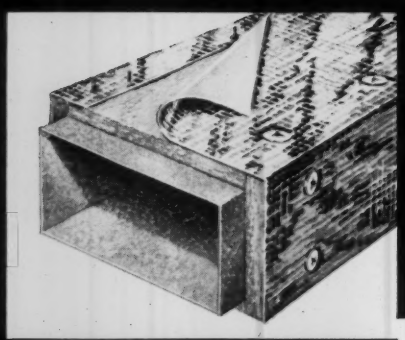

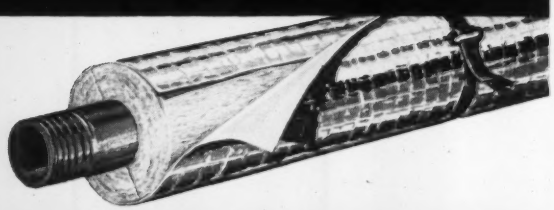

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- *Permanently non-combustible*
- *UL flamespread rating — under 30*
- *Perm rating less than 0.1*
- *Stronger for no-tear application*
- *Better textures for best appearance*

Pyro-Kure vapor barriers will up-grade the insulation with which they are combined. A unique manufacturing development provides *permanent* flame resistance. The adhesive used for laminating the multiple plys of kraft, foil or plastic film and the reinforcing fibers emits a gas at combustion temperature. This gas will snuff out the flame when the ignition source is removed. These products, then, are self-extinguishing.

Pyro-Kure vapor barriers are available in various combinations and standard widths. All of them provide excellent protection against condensation and at a cost equal or below similar vapor barrier material which is still not permanently flame resistant.

Leading insulation manufacturers are now combining Pyro-Kure with their products. For your guarantee of the best, specify "Pyro-Kure."

Write Dept. HP1 for more facts on this new vapor barrier line.

*Patent Applied for.

SISALKRAFT

AMERICAN SISALKRAFT CORPORATION
Chicago 6 • New York 17 • San Francisco 5
In Canada: Murray-Brantford Ltd., Montreal

reinforced paper, foil and plastics for construction, industrial packaging and agriculture

NEW!

ARROW AH HART

CONTROL CENTERS

TYPE "MC"

these advantages will help you

MUCH GREATER SPACE SAVINGS . . . because the Arrow-Hart Motor Control Units in these Control Centers are half the size and weight of comparable controls. *ARROW-HART* offers a control center with up to 10 Size 1 control cells in a single vertical section 90" high.

FASTER, LOWER-COST INSTALLATION . . . because all controls are delivered in a single pre-tested, ready-to-install "package." If specified, all interwiring, sequencing, interlocking etc. are pre-engineered.

GREATER DEPENDABILITY . . . because of the superior performance of the individual Arrow-Hart Control Units and simplified maintenance because all controls are centralized in a single convenient location, away from shop dust and dirt. Individual cells are plug-in type for quick removal, replacement or re-assembly.

COMPLETE FLEXIBILITY, VERSATILITY . . . practically any desired combination of units can easily be assembled . . . or modified.

MOST COMPLETE LINES AVAILABLE ANYWHERE . . .

COMBINATION STARTER UNITS: Non-Reversing, Reversing, 2-Speed, Part-Winding, and Reduced Voltage Starter Types in NEMA Sizes 1 through 5 . . . in combination with Fused or Unfused Disconnect Switch or Circuit Breaker of Thermal Magnetic or Instantaneous Trip Type.

ENCLOSURES: NEMA 1 (General Purpose), NEMA 1-A (Semi-Dustight), NEMA 3 (Outdoor), NEMA 5 (Dustight), and NEMA 12 (Industrial Use) — in standard or back-to-back arrangements.

WIRING: NEMA A, B or C — Class I or II.

OTHER CONTROL UNITS: Include Lighting Panels, Transformers, Metering Equipment, and a Complete Line of Pilot Devices.

TYPE MC-5
20" WIDE
Up to 5 Size 1 Control Cells

preferred for most general purpose industrial applications.

GET COMPLETE INFORMATION NOW!
Write today for fully descriptive literature. The Arrow-Hart & Hegeman Electric Company, Dept. HPAC, 103 Hawthorn St., Hartford 6, Conn.

ARROW AH HART

Quality since 1890

MOTOR CONTROLS · ENCLOSED SWITCHES
APPLIANCE SWITCHES · WIRING DEVICES

TYPE MC-10
25" WIDE
Up to 10 Size 1 Control Cells

preferred for schools and other commercial, and institutional applications that call for maximum space savings.

HEADROOM PROBLEMS

are but one of many reasons why leading gas companies now recommend a

DRAFT CONTROL

for commercial-industrial GAS equipment

Proven in thousands of gas installations, Field does everything a draft diverter does—AND MORE—offering new simplicity, new flexibility, new precision in the control of draft.

Here's how Field helps make **GAS** an even finer fuel:

1 — **COMPACT SIZE: Field** is small, compact, can be placed in a variety of approved locations. Limited headroom no longer presents a draft problem.

2 — **DRAFT ASSISTANCE:** With **Field** you can utilize the draft assistance of the chimney, with settings as low as .002", as high as .35". Draft-short installations are avoided.

3 — **LOAD FLEXIBILITY:** With a **Field** firing rates can be varied — increased for increased loads, or decreased, and without loss of efficiency. Now gas is an even more flexible fuel.

4 — **REDUCED CONVERSION COSTS:** With a **Field** no change in breeching area is required when converting from coal or oil. Now it is quicker, simpler, less costly to convert to gas.

5 — **REDUCED "START-UP" SPILLAGE:** by avoiding loss of chimney prime, permitted with a diverter, **Field** minimizes the spillage caused by cold stack resistance.

6 — **AUTOMATIC CONTROL: Field** not only gives visual evidence of any spillage, but, when switch-equipped, spillage will automatically actuate virtually any response an engineer may specify. Thus **Field** permits still another refinement in the industry's meticulous handling of its fuel.

If you design, specify, install or approve gas-fired equipment consult Field engineers for draft control recommendations.

FIELD CONTROL DIVISION

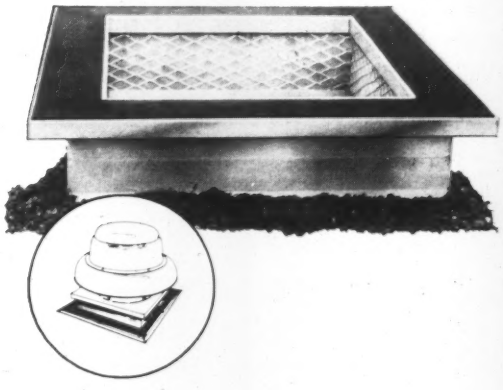
Conco Engineering Works, Inc., Mendota, Illinois

AFFILIATES:

Spartan Tool Division — Powered Sewer Cleaning Equipment
Materials Handling Division — Cranes, Hoists
Conco Building Products, Inc. — Brick, Tile, Stone

field

THE FIRST TO CURB ROOF EXHAUSTER NOISES WERE ENGINEERS AT PENN!



Penn's SONOTROL CURB *for all roof ventilator installations provides* 3 IMPORTANT BENEFITS *to the Specifying Engineer*

Putting the curb on prevailing problems that accompany roof ventilator installations was no easy task. Roof fan sounds had to be hushed. Field constructed curbs were often haphazardly put together; they overloaded roofs and lacked dimensional coordination for ventilators and dampers. But, engineers working at Penn developed the industry's first solution . . . the *Sonotrol Curb!*

EXTRUDED ALUMINUM, an exclusive in Penn's Sonotrol design features structural "I" beam lifetime construction; reinforced seamless outside wall; loading capability of more than 700 lbs. per lineal ft. with a minimum safety factor of 2.5; provides stabilized dimensions for all dampers and ventilators . . . and everything fits!

ACOUSTICAL-THERMAL INSULATION reduces decible build-up of exhauster at the source; attenuates resonance and reverberation; minimizes sone values; no reduction in air movement.

SELF-FLASHING eliminates the problem of field flashing over the Curb; installation is simplified; flashing flange incorporates V-groove serrations for maximum gripping power.

Get complete facts now on how Penn Ventilator can be your one source for the universally accepted Sonotrol Curb, Damper and Ventilator. Contact your local representative or write direct.

PENN VENTILATOR CO., Inc.
PHILADELPHIA 40, PENNA.

A leading manufacturer of Powered and Gravity Roof Exhausters and Accessory Equipment for over 30 years.

Charter Member of AMCA

Penn Ventilator products are available throughout the Free World.
One of many direct factory representatives at your service:
Barrow & Daugherty, Atlanta, Ga.

In the busy summer months ahead...

INSIST ON genetron®

SUPER-DRY REFRIGERANTS

...and be sure of the best!

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TRICHLOROMONOFLUOROMETHANE

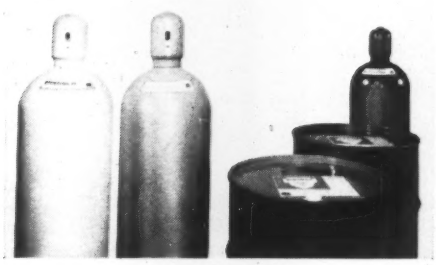
genetron 12 WHITE LABEL CCl_2F_2
DICHLORODIFLUOROMETHANE

genetron 22 GREEN LABEL $CHClF_2$
MONOCHLORODIFLUOROMETHANE

genetron 113 PURPLE LABEL $C_2Cl_3F_3$
TRICHLOROTRIFLUOROETHANE

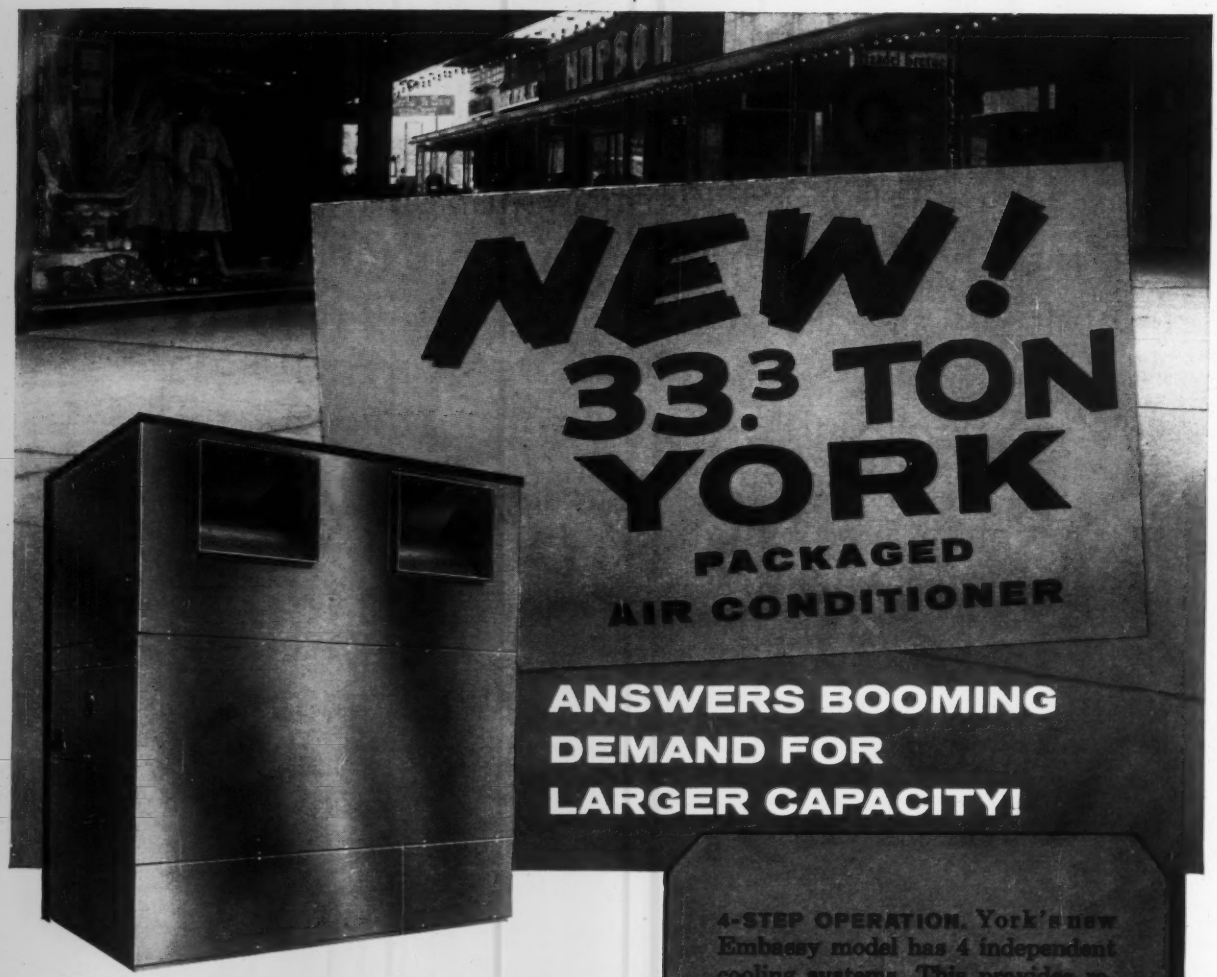
genetron 114 BLUE LABEL $C_2Cl_2F_4$
DICHLOROTETRAFLUOROETHANE

genetron super-dry refrigerants are universally accepted for use as original or replacement charge because their tight production standards consistently **e**xceed industry specifications for purity and dryness. Refrigeration service engineers, original equipment manufacturers and wholesalers throughout the **n**ation know they can always rely on "genetron" for dependable, trouble-free performance. "Genetron" super-dry refrigerants are available from wholesalers **e**verywhere. Their high quality is backed up by fast, dependable service—including prompt return of deposits on empty cylinders—and extensive **t**echnical help. More than a million copies of the "genetron service tip of the month" are mailed out every year. Pressure-enthalpy charts are available for **r**efrigeration service engineers to use in their work. Special sound slide films on solving refrigeration and air-conditioning problems are shown regularly to **o**riginal equipment manufacturers, servicemen, contractors, trade schools and universities. Whenever you order modern refrigerants, remember the **n**ame—"genetron"! Do as so many others are doing. Use the very best! When you see your wholesaler, always insist on "genetron" super-dry refrigerants!



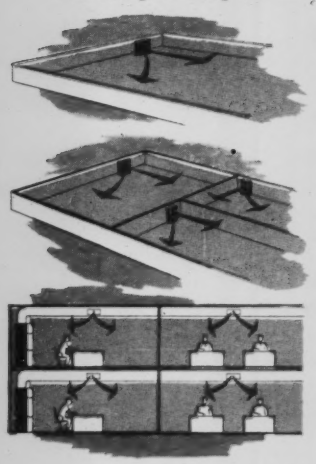
Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.



ANSWERS BOOMING DEMAND FOR LARGER CAPACITY!

Easily Adapts to Any Cooling Need!



Zone Cooling
A single Embassy without ductwork easily cools large open areas.

Room by Room
Individual Embassys for large rooms. Central unit with ductwork for small rooms.

Floor by Floor
One or more Embassys on each floor with simple ductwork to partitioned areas.

Other Embassy Models from 3 to 25 ton capacity

4-STEP OPERATION. York's new Embassy model has 4 independent cooling systems. This provides reserve systems which automatically swing into action on hottest days. Customer is able to maintain desired comfort level under varying load requirements...yet pays only for the cooling he needs.

30% MORE HUMIDITY REMOVAL! York's Exclusive Cooling Maze Coils force air to twist, turn, and ricochet around staggered tubes and rippled fins. Excess moisture disappears.

MINIMUM INSTALLATION COST! Self-contained units can be placed anywhere. No need to overhaul the building or interrupt business operation. Additional units can be added as needed.

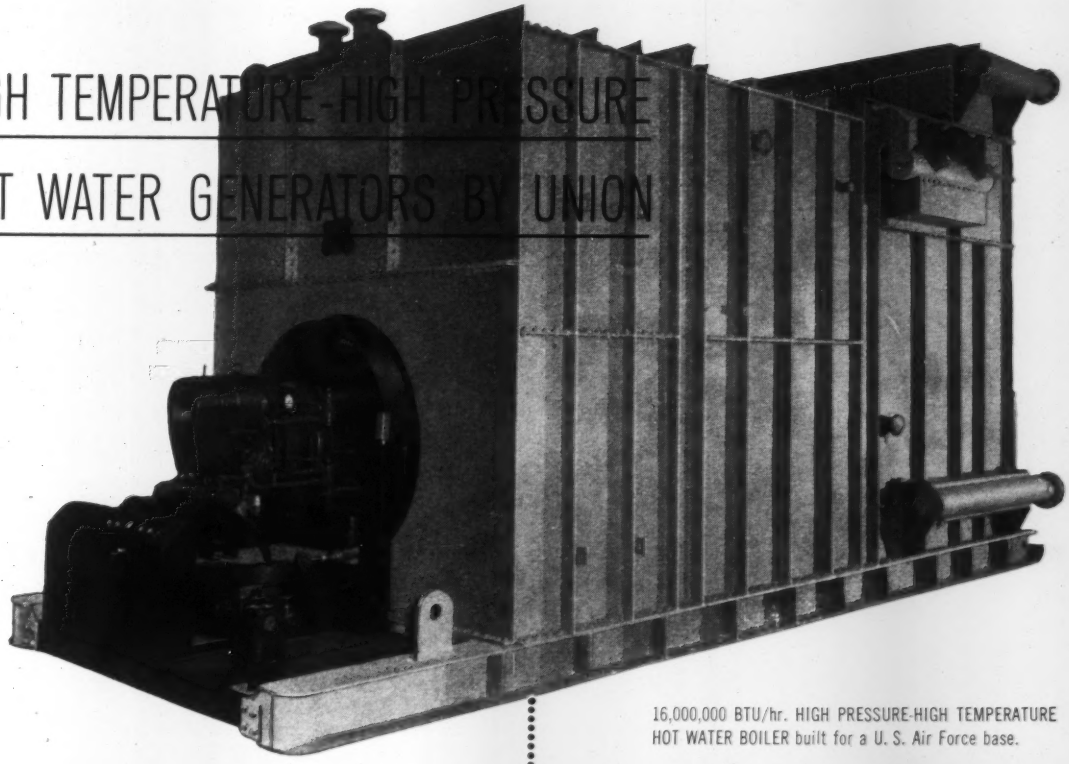
York Puts More Into Every Unit
So You Get More Out of It

YORK
YORK CORP., SUBSIDIARY OF BORG-WARNER CORP.
GRANTLEY ROAD, YORK, PENNSYLVANIA

YORK B-W DIVISION
BORG-WARNER RESEARCH & ENGINEERING MAKE IT BETTER

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Installations

HIGH TEMPERATURE-HIGH PRESSURE HOT WATER GENERATORS BY UNION



16,000,000 BTU/hr. HIGH PRESSURE-HIGH TEMPERATURE HOT WATER BOILER built for a U. S. Air Force base.

SHOP ASSEMBLED UNITS INSTALLED WITHOUT COSTLY FIELD BALANCING

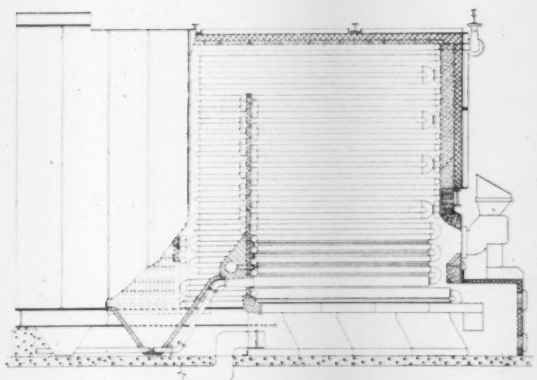
Right from the start, you can save with a Union shop assembled HTHP Hot Water Generator. With all of its circuits of the same hydraulic length, time consuming field balancing can be eliminated. Most units do not require orifices or any other mechanical adjustments to equalize flow at the time of installation.

High water velocities (above 5 ft./sec.) and liberally proportioned, water cooled furnaces eliminate localized overheating. As there are no multi-tube circuits in the radiant section, recirculation within a circuit is impossible, thereby eliminating vapor binding or stagnant flow areas.

Liquid and gas flow run counter to each other. With the liquid inlet positioned at the top of the convection section, the lowest temperature liquid is served by the lowest temperature gas. As a result, generator efficiency is improved and the risk of thermal shock minimized.

Standard units (both shop assembled and field erected) can be modified to meet a wide range of job requirements. They can be arranged for firing with most commercial fuels as well as waste fuels in liquid, gaseous or solid form.

For specific information, outline your requirements to a Union representative or contact Union Iron Works.



31,000,000 BTU/hr. FORCED CIRCULATION, HIGH PRESSURE-HIGH TEMPERATURE HOT WATER BOILER. Equipped for firing by an oscillating grate spreader stoker with fly ash reinjection. Fully factory-assembled for shipment.

UNION

UNION IRON WORKS • ERIE, PENNSYLVANIA

water tube steam generators and allied equipment

POWELL
DEPENDABLE
VALVES

Performance makes the world of difference

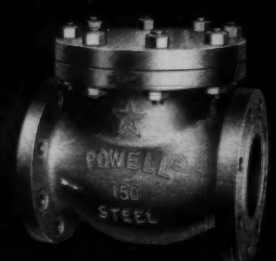


Fig. 1561—Steel lift check valve for 150 pounds W.P. Steel valves are available for pressures from 150 to 2500 pounds.

Fig. 1793—Iron body bronze mounted gate valve for 125 pounds W.S.P. Outside screw rising stem and yoke. Solid or split wedge, renewable seats.

Fig. 375—Bronze gate valve for 200 pounds W.S.P. Union bonnet, inside screw rising stem, interchangeable solid or split wedge, integral seats.

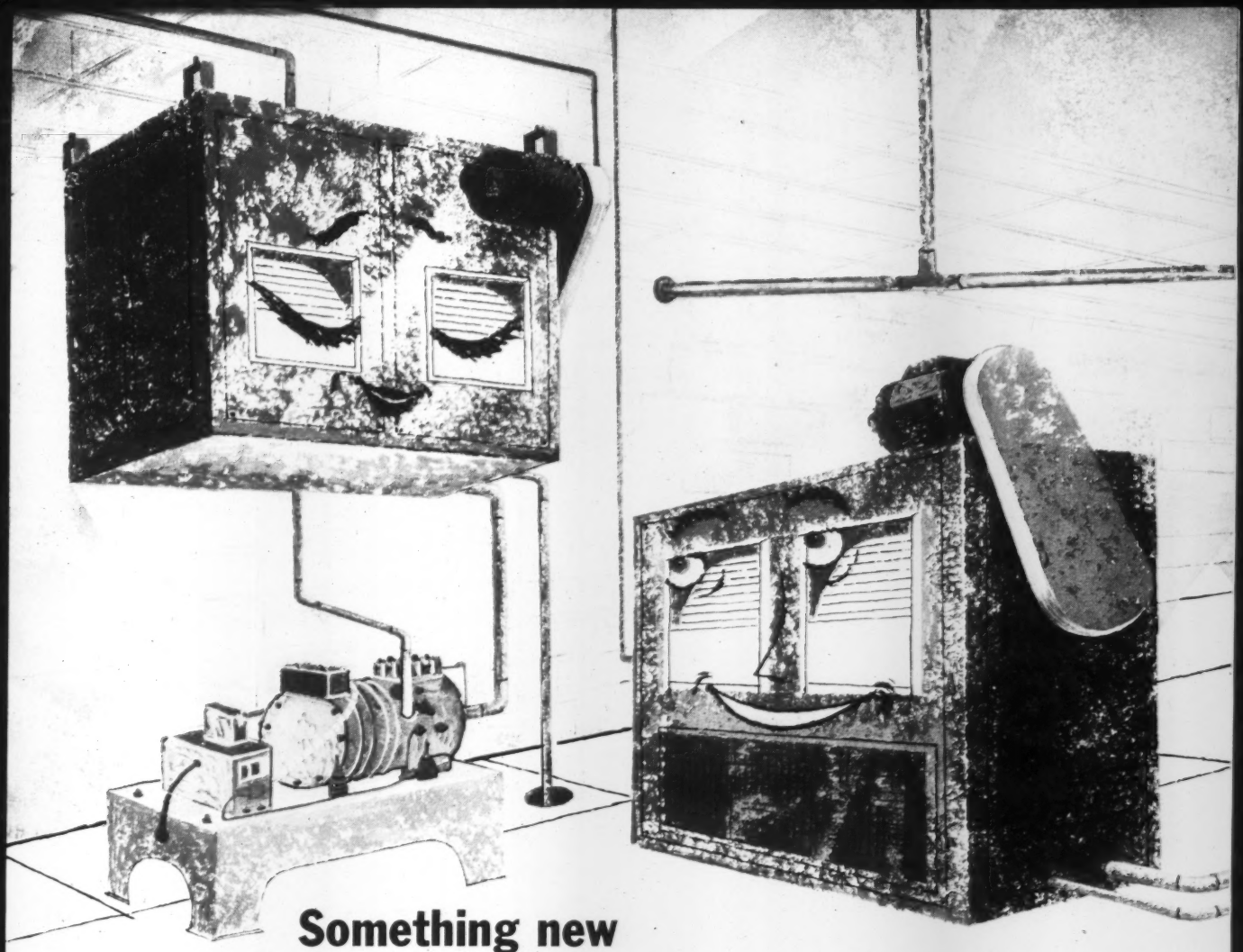
No matter what your flow control requirements may be—handling water, oil, gas, air, steam, corrosive fluids—Powell Valves can be depended upon to take care of them to your complete satisfaction.

All types are available—in bronze, iron, steel and such corrosion-resistant metals and alloys as stainless steel, nickel, Monel metal, and others—for pressures from 125 to more than 2500 pounds WP—and temperatures from sub-zero to super-heat.

Most of these valves are in stock for immediate delivery. So one quick call to your nearest Powell Valve distributor or directly to us can fill all your valve needs.

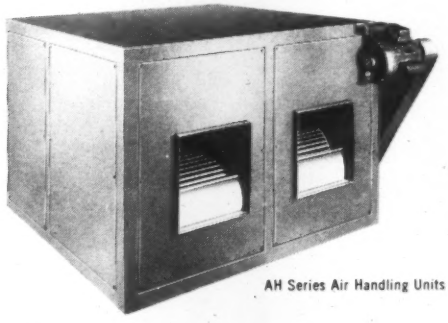
Powell . . . world's largest family of valves

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO



Something new for the air conditioning boys... and coils!

Now, Air Handlers from Halstead & Mitchell in 880 to 47,500 CFM Range



AH Series Air Handling Units

Before you buy any Air Handler, check and compare these new H&M units, feature for feature and price for price.

See how easily H&M Air Handlers accommodate matching cooling and heating coils, with space for up to 12 rows of coil depth overall! If you like, H&M coils (from 2 to 68 square feet of face area) can be factory-installed, leaving protruding connections on either side for easy hook-up. Halstead & Mitchell makes the coils you need to match: direct expansion, chilled water, hot water, standard or non-freeze steam. Filter sections are also available.

Performance? H&M Air Handlers deliver air against static loads up to 2-inches water gauge, and do it quietly.

Construction? They're the sturdiest units in the field. Forward curved centrifugal blowers are enclosed in a heavy gauge cabinet featuring formed steel corner posts and flush mounted panels.

Price? Just ask your H&M distributor. You'll be pleased. He has all the engineering information, too. Or, you can write for Bulletin AHU-100, Halstead & Mitchell, Bessemer Building, Pittsburgh, Pa.

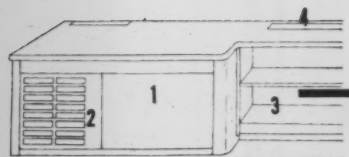
HM

Halstead & Mitchell

Air Handlers • Finned Coils • Air-Cooled Condensers • Cooling Towers • Water-Cooled Condensers

Gas-fired **Norman Schoolroom Heating and Ventilating System** heats the classroom before the first bell, answers any call for heat quickly, automatically. Modern Norman forced warm-air system supplies fresh outdoor air for cooling, recirculates room air for ventilation and distributes tempered air evenly while maintaining uniform temperature. A bell-ringer in economy too, Norman System cuts installation, operation and maintenance costs.

Write Today for New 1960 Comprehensive Manual
See folder in 1960 Sweets Arch. File 31h/No



1. FURNACE ENCLOSURE 2. RETURN AIR GRILLE
3. UTIL-I-DUCT® BOOKSHELF 4. AIR DIFFUSER

Norman®

PRODUCTS CO. • 1156 Chesapeake Ave. Columbus 12, Ohio

only SPORLAN can offer you Peak Performance Solenoid Valves for Refrigerants, Water, Steam or Hot Gas Applications

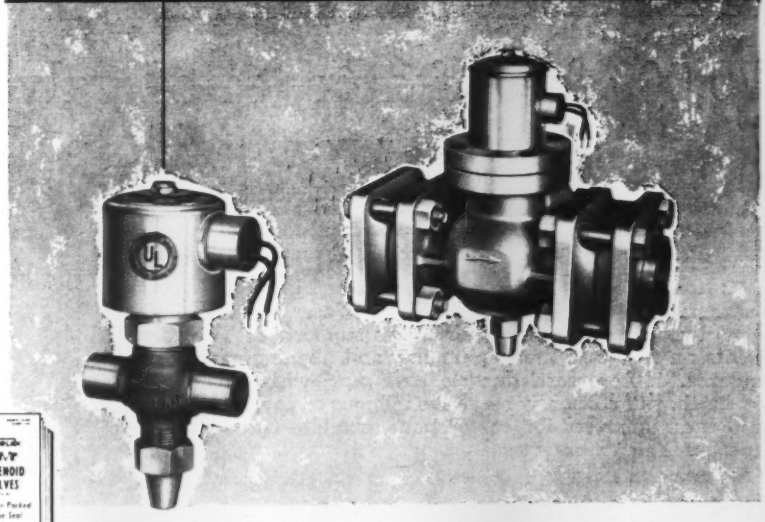
with these... **FAMOUS FIRSTS!**

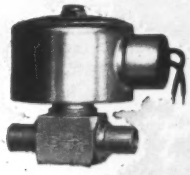
SYNTHETIC SEATING 1946

COLOR CODED LEAD WIRES 1955

PILOT CONTROL 1940

Sporlan's famous power packed Blue Seal Coils provide the valves with their high MOPD rating ...permitting the use of most valves for either Refrigerants 12 or 22





See your Sporlan Wholesaler today for complete information and be sure to ask him for Bulletin 30-10. Then you'll know why Peak Performance means so much on any solenoid valve installation!

SPORLAN VALVE COMPANY

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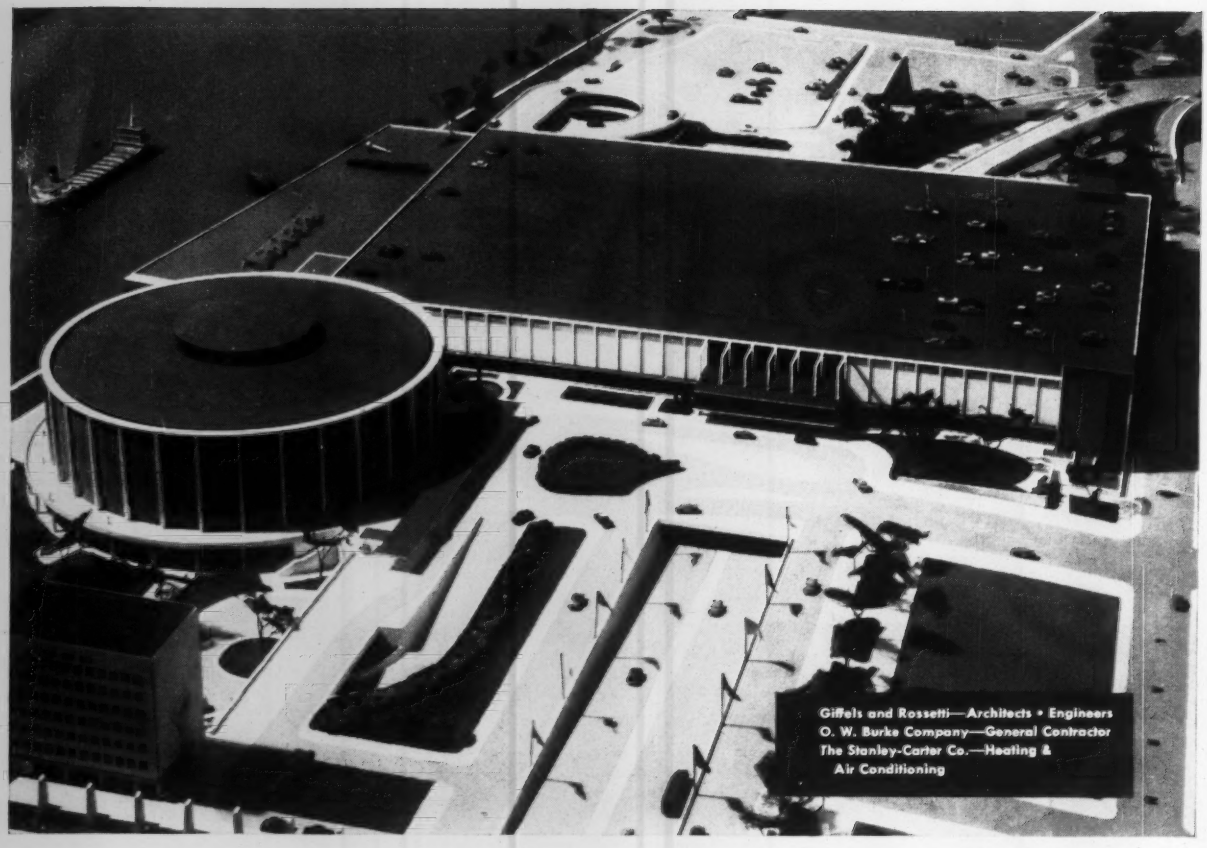
EXPORT DEPT. • 85 BROAD ST. • NEW YORK 4, N. Y.


Giffels and Rossetti—Architects • Engineers
O. W. Burke Company—General Contractor
The Stanley-Carter Co.—Heating &
Air Conditioning

70,000 feet of time-tested galvanized **steel pipe** will serve Detroit far into the 21st Century

In the new multi-million dollar Cobo Hall and Convention Arena in Detroit's civic center, galvanized *steel pipe* is used for water, drainage and vent systems. The reasons why?

1: Longer lengths of *steel pipe* meant fewer joints with commensurate installation economies. 2: Water, drainage and vent lines of *steel pipe* required less support. 3: Threaded joints on *steel pipe* made plumbing and aligning easier and quicker. 4: Low cost, durable *steel pipe*, with its built-in strength, will efficiently serve the millions of people who will use these quarters for conventions, exhibits and spectator sports for generations to come.

Steel pipe remains the first choice in outstanding buildings throughout the country. It is dependable, reliable and low in cost for gas, air and water transmission, fire sprinkler systems, electrical conduit, structural uses, radiant heating, snow melting, refrigeration and cooling . . . and it has always been easily and readily available anywhere in the country.

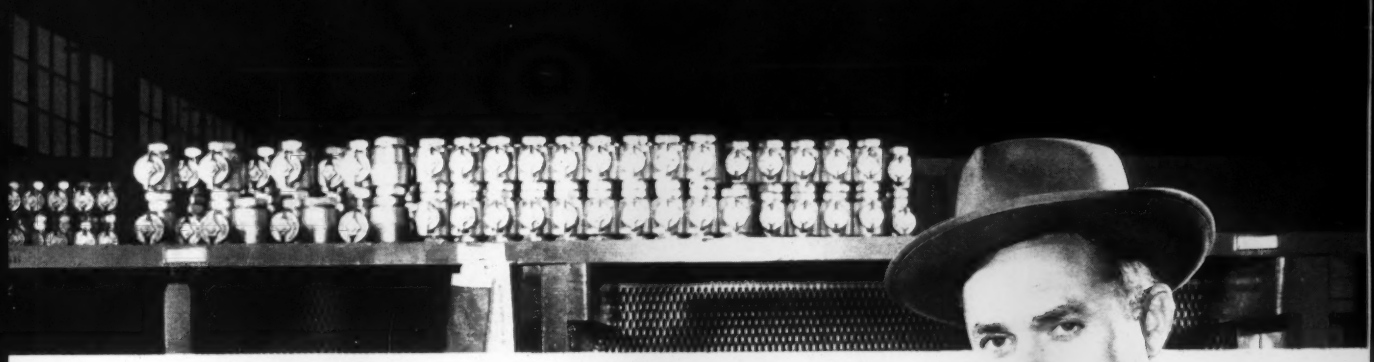
90% of domestic water, drainage and vent lines require horizontal suspension. Because steel pipe is easy to install and needs less support, significant economies are effected in installation.

STEEL PIPE IS FIRST CHOICE

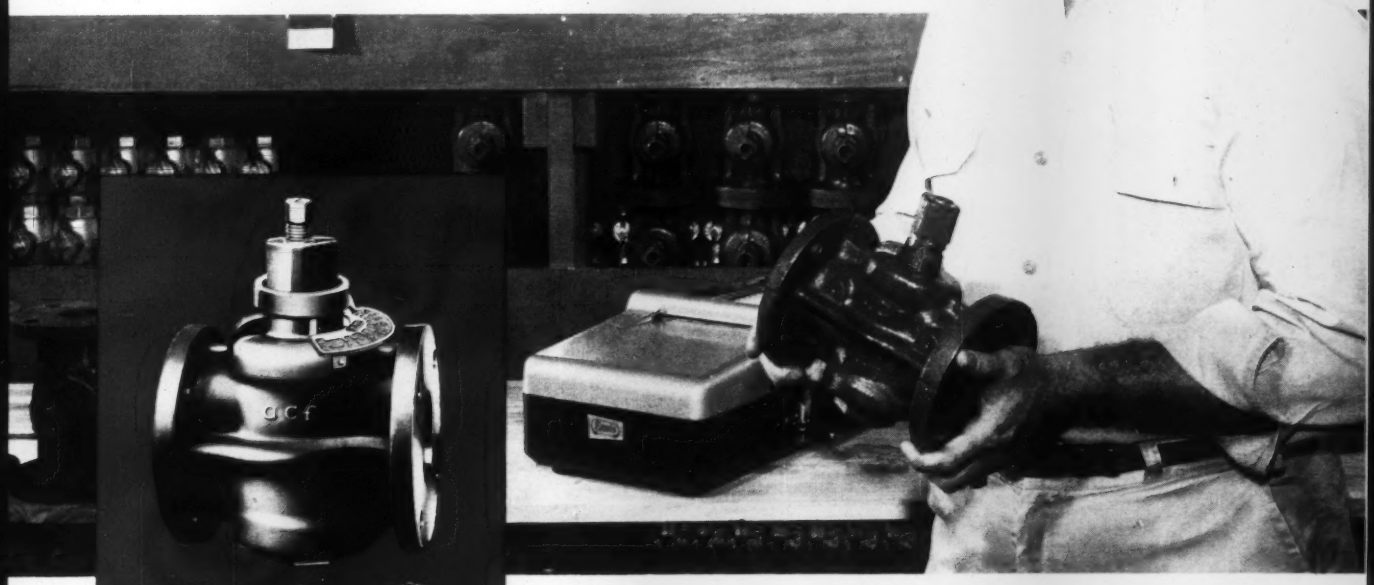
- Low cost with durability
- Strength unexcelled for safety
- Formable—bends readily
- Weldable—easily, strongly
- Threads smoothly, cleanly
- Sound joints, welded or coupled
- Grades, finishes for all purposes
- Available everywhere from stock

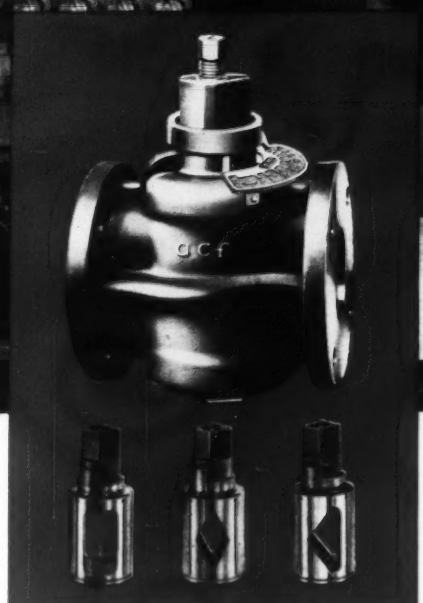
Insist on MADE IN USA Steel Pipe

COMMITTEE ON STEEL PIPE RESEARCH
150 East Forty-Second Street, New York 17, N.Y.



"Best valve made for air conditioning!"





Dial Indicator for Balancing Rectangular, Diamond or V Ports

All ACF Plug Valves may be equipped with dial indicators, which save time and inconvenience in recovering proper balance in air conditioning systems.

In addition to the popular rectangular port, ACF Plug Valves are also available in diamond and V port models for even more accurate flow control.

Product of W-K-M's *Creative Engineering*

acf® Plug Valves

ACF lubricated plug valves give positive control at minimum expense for air handlers, compressing units, natural gas or fuel oil lines, and water towers.

No matter how long between operations, ACF plug valves open and close with an easy quarter-turn. Friction surfaces are constantly lubricated for smooth turning and protection against corrosion. A teflon gasket backed-up by a lubricant reservoir seals the head seat. The cylindrical plug — with a well-proportioned full pipe area port — provide an effective seal in the line.

Next time — and every time — specify ACF! *Available from leading suppliers everywhere.*

WRITE FOR BULLETIN AP-1059

W-K-M

DIVISION OF acf INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5924

BRUTE STRENGTH

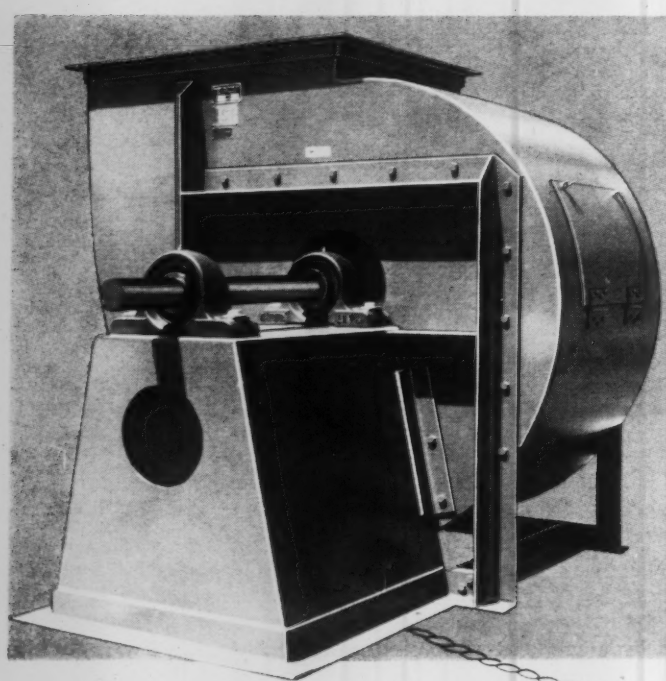
RUGGED CONSTRUCTION

SKILLED ENGINEERING

make

BARRY *Centrifugal Fans*

PERFORM WITH PERFECT SATISFACTION



Shown here is our No. 330 BBC SWSI arrangement 1 Fan, with ratings certified by AMCA . . . just one of a whole family of efficiently-engineered Barry fans, giving dependable daily performance all over America.

All Barry fans are ruggedly built to give long dependable service. Such things as extra heavy framing, oversized shafts, heavy duty bearings, welded housings, TG&P shafts, and dynamically balanced impellors, are taken for granted by users of Barry blowers, because they know such construction is typical of the entire Barry line.

The fan shown is handling air in the asphalt plant of a large midwestern city at high pressure and high temperature. Whatever YOUR blower problem may be, there's a Barry fan that can solve it. Tell us your problem—we'll come through with the correct solution, plus speedy delivery!

PERFORMANCE RATING
CERTIFIED BY AMCA

member of air moving and conditioning association inc.

BARRY BLOWER CO.

3100 CALIFORNIA ST. N. E., MINNEAPOLIS 18, MINN.

FC VENTILATING FANS • INDUCED DRAFT FANS • STEEL PLATE FANS • FAN WHEELS AND SCROLLS • BBC VENTILATION FANS • FORCED DRAFT FANS • FUME EXHAUST FANS • UTILITY EXHAUSTERS • BELTED VENTILATING SETS • MATERIAL HANDLING FANS • MEDIUM PRESSURE BLOWERS • SPECIAL APPLICATIONS

The Producers' Council of
THE AMERICAN INSTITUTE OF ARCHITECTS
*awards** Certificate of Merit *to*

WATERLOO CATALOG

*Presented at the A.I.A. Convention in San Francisco on April 18, 1960

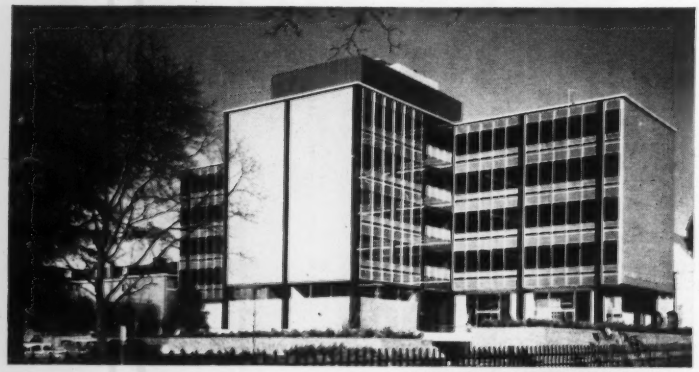
The Producers' Council, Inc. of Washington, D.C. has awarded a Certificate of Merit in the 1960 Building Products Literature Competition to a comprehensive air diffusion equipment catalog published by Waterloo Register Co., Inc. The Award was made for "an outstanding effort in the production of informative, high quality product literature."

Write for your free copy of this comprehensive guide to the quality-built Waterloo line.

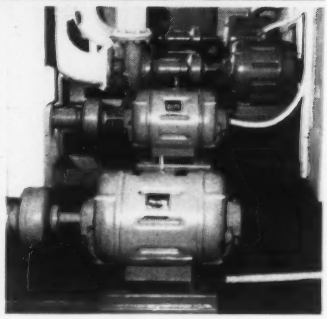
WATERLOO REGISTER COMPANY, INC.
P.O. BOX 72, WATERLOO, IOWA

WATERLOO *Air Diffusion* EQUIPMENT

WR129



Home Security Life Insurance Company Building, Durham, N.C., is equipped with B&G Universal Pumps. "The pumps couldn't be any quieter," says the plant engineer.



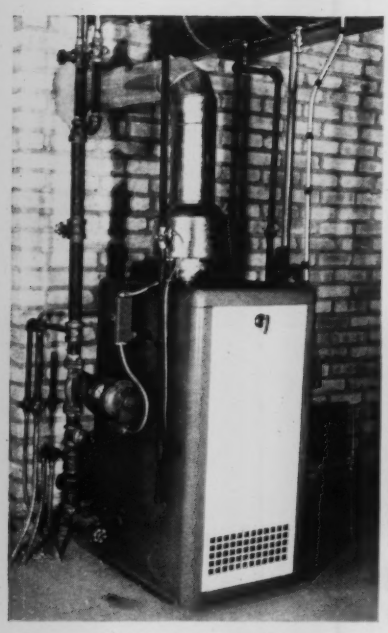
B&G® BOOSTER AND UNIVERSAL PUMPS

quiet... where silence counts

Whether for residential or commercial applications of a forced hot water system, *quiet* operation of the circulating equipment is essential. A noise-creating pump can be a headache and a profit-wrecker for all concerned—architect, engineer, contractor and owner. That's why men responsible for pump selection are concentrating on B&G Boosters and Universals—for the simple reason that they will not be plagued later with noise complaints.

Since the manufacture of its first heating pump, B&G has been conscious of the need for silent, vibrationless operation. Today, B&G pumps have reached a peak of perfection—they are incredibly quiet—need no flexible connections or vibration eliminators. From B&G-built motors to B&G-developed, harder-than-glass "Remite" leak-proof seals, these pumps are *specialized* units.

B&G Boosters and Universal Pumps are available in a wide range of capacities with 1/12 to 40 H.P. motors.



The comforts of B&G Hydro-Flo Heating are obtained from a unit smaller than a refrigerator.

These homes have modern Hydro-Flo hot water (hydronic) heating systems equipped with B&G Booster Pumps. Builder reports that the many exclusive advantages of B&G Hydro-Flo Heating helped sell these homes fast.

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LABOR COSTS FOR INSULATING LINES CUT IN HALF BY B.F.GOODRICH CELL-TITE INSULATION TUBING

EVEN when pipe has already been connected, B.F.Goodrich insulation tubing can be slit, snapped on and cemented in seconds. And, if you prefer, you can get it pre-slit for even faster installation. Slitting is unnecessary for new lines—it slips on straight or bent pipe as easily as a ring on your finger. Installation is so fast that labor costs for insulating pipe can be cut 50% or more over old-fashioned twine-wrapping, skirting and other slower methods.

B.F.Goodrich insulation tubing is made of a tough, flexible rubber with millions of uniform, non-connecting cells that seal out air and moisture. It can be used for insulating pipes carrying hot or cold liquids at temperatures ranging from —20°F to 200°F. Clean and easy to work with, doesn't rub off, chip or crumble. It comes in 6-foot lengths, in many wall thicknesses, that are easy to handle, easy to store.

This BFG insulation is also self-extinguishing, so it can be installed on copper tubing before sweat fittings are made—tubing is merely pushed back and held by clamps while joint is soldered.

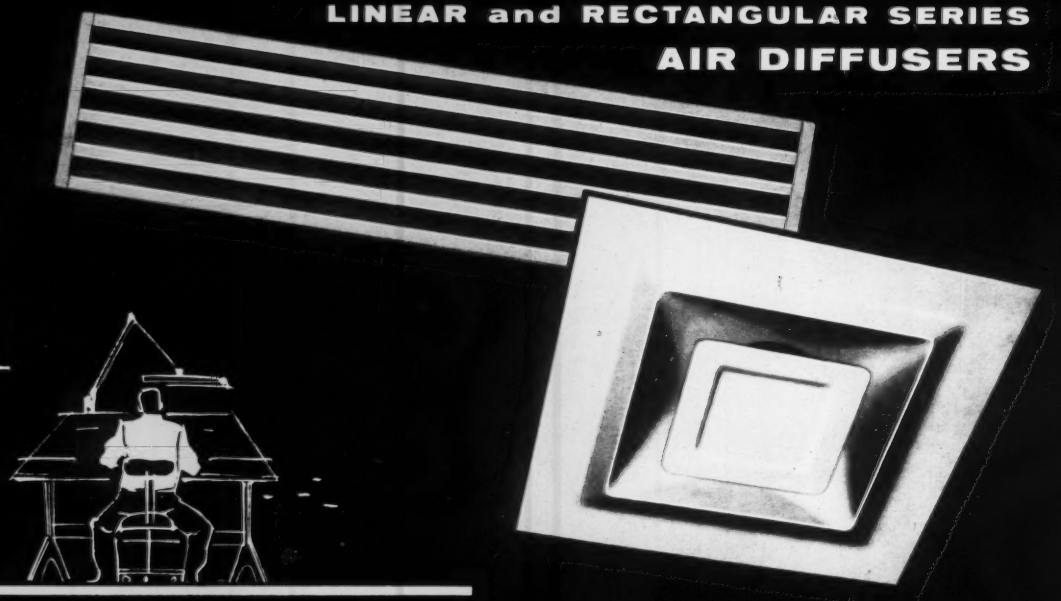
Try this labor-saving insulation on your next job. For full information on BFG insulation tubing, call your B.F.Goodrich distributor, or contact *The B.F.Goodrich Company, 181 Derby Place, Shelton, Conn.*

INSULATION TUBING BY B.F.Goodrich

function-perfect . . . . fashion-right

the kno·draft® "ARCHITECTS' GROUP"

LINEAR and RECTANGULAR SERIES AIR DIFFUSERS



As the name explicitly implies, the "Architects' Group" provides architects, engineers, and their customers with a comprehensive line of air outlets that combines the best air distribution with graceful, unobtrusive modern styling.

Especially designed to complement the essentially rectilinear pattern of interior architectural schemes, the "Group" consists of three series—squares, panels, and long-slotted, or linear. To satisfy different structural or functional demands, each series is available in several types . . . and each type can be furnished with all optional accessories necessary to meet any air diffusion requirement.

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mastics	60-25/26	C. I. MASTICS	Asphalt vapor-barrier weathercoats	M-1-A/B
	* 60-30N/60N	FIRE-RESISTIVE MASTICS	Non-asphaltic flexible weathercoat with non-flammable solvent	M-1-A/B
adhesives	81-13	ADHESIVE A-90	Brush-grade adhesive for low-density insulations	A-1-A/C
	81-33	FIRE-RESISTIVE ADHESIVE	Hard-setting for rigid high-density insulations	A-1-A
	81-42W	LAGFAS	Economical adhesive for lap-sealing and sizing canvas	A-1-B
	81-60	FIRE-RESISTIVE ADHESIVE	For blanket or high-density duct insulation	A-1-A/C
	81-63/66	INSULATION ADHESIVES	Low-cost brush and trowel-grade adhesives	A-1-A
	81-71/81	DUCT-FAS	Quick-tack with long-open time adhesives for duct insulations	A-1-A/C
	81-91	DUCT-FAS WHITE	For lap-sealing white vapor-barrier jackets on pipe covering	A-1-A/C
	82-18	DUCT-FAS QUICK-TACK	Fast-setting clear rubber cement for insulation facings and jackets	A-1-A/C
	* 81-99	SAFETEE DUCT-FAS	Non-flammable, fire-resistive duct-insulation adhesive	A-1-A/C
coatings	30-42	VINYL VAPOR BARRIER	White vapor-barrier finish coat	C-1-A
	* 30-36	SEALFAS	Light-colored fire-resistive, abrasion-resistant sealer	C-1-A
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SELF-FLUXING ACTION OF 4-D WROUGHT IRON CONTRIBUTES TO SOUND, DURABLE WELDS

For superior 4-D Wrought Iron welding results, reduce your welding speed slightly below that used for steel. In electric welding, also reduce the current slightly. With oxy-acetylene welding, a neutral flame is best.

Two-Component Material—4-D Wrought Iron consists of two distinctly different components: high purity iron base metal and glasslike iron silicate. The fluxing action of the silicate protects the base metal during heating. This enables welders to easily produce sound, durable welds.

Melting Characteristics—Each of 4-D Wrought Iron's two components has its own fusion temperature. The siliceous material melts first (2100°-2200°F), several hundred degrees before the iron (2730°F). But don't confuse the fluxing of the iron silicate with melting of the actual base metal. Just continue heating until the iron fuses.

Welding Processes—4-D Wrought Iron Pipe may be easily joined through a number of commonly used welding processes: forge welding, electric resistance welding, oxy-acetylene welding, electric metallic arc, electric carbon arc and submerged arc welding, and bronze welding.

Welding Procedures—Weld slowly enough to allow the siliceous material to float out of the weld. Avoid unnecessary rubbing or agitation of the molten metal. It causes formation of oxides which may be trapped.

Fittings Available—4-D Wrought Iron welding fittings for pipe are available in a complete range of sizes, including bends, Van Stone welding stubs, reducing nipples, tees, crosses, and caps. Fabricators in many cities produce 4-D Wrought Iron welding fittings.

Bonney Forge and Tool Works, Allentown, Pa.; Heat and Power Corp., Baltimore, Md.; Ladish Company, Cudahy, Wis.; Midwest Piping and Supply Company, St. Louis, Mo.; Taylor Forge and Pipe Works, Chicago, Ill.; and Tube Turns, Inc., Louisville, Ky., manufacture extensive lines of 4-D Wrought Iron welding fittings.

Write for comprehensive welding booklet: A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.

BYERS 4-D WROUGHT IRON

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ALSO AMBALLOY ELECTRIC FURNACE STEELS
AND PVC PIPE, SHEET AND ROD STOCK

Corrosion costs you more than Wrought Iron

DU PONT ANNOUNCES...

New "Zephyr" Containers for "Freon" Designed for Your Convenience

- Built-in carrying handle
- Can be used upright or inverted
- Can be stacked
- New handwheel valve
- Lighter in weight
- New 50 lb. size

These new "Zephyr" containers can be used either upright or inverted without special blocks or stands. A permanent collar protects the valve and serves as a built-in carrying handle. These are the only refrigerant containers that can be stacked one on top of the other. They are shorter—lighter—easier to carry. A 50 lb. size is now practical. No wrenches are needed because these new containers also have a new type handwheel valve. They will stand upright in your truck.

"Freon-12" and "Freon-22"—the premium quality refrigerants—are now available in these new "Zephyr" containers in 25 and 50 lb. sizes from your *leading* air conditioning and refrigeration wholesalers. Place your order for "Zephyr" containers today.

Please turn page for another announcement

NEW TOP *and* VALVE

are being added for your convenience

to Standard 25 lb. cylinders for "Freon"

This new "Spintop" cylinder is now available in addition to the Standard 25 lb. cylinder with hood cap. The "Spintop" is a convenient carrying handle, valve protector and stand. Being free to rotate, it provides easy access to the valve. The regular valve has been replaced with a convenient handwheel type that includes a special spring-loaded pressure relief device for added safety.

Now—a Container for Every Use

For your convenience "Freon" refrigerants are offered in a family of containers*. Each of these types of containers has its own distinctive advantages. The container that best suits your needs is available from your leading air conditioning and refrigeration wholesaler. Call him today for your order of "Freon" refrigerants.

**1 or 2 lb. "Can-O-Gas" containers of "Freon" refrigerants are available from the Virginia Smelting Co., our nationwide sales agent and authorized repackager.*

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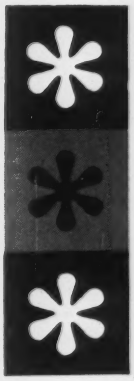
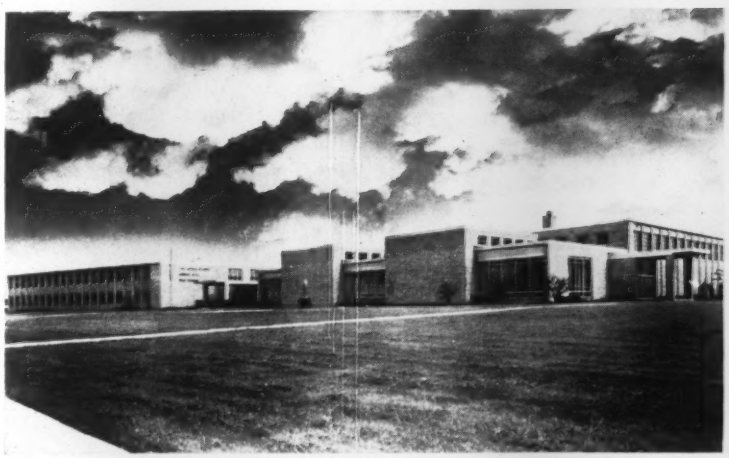


Heat New High School Six Ways in Six Zones

IN DETERMINING the method of heating and control for the new Mother McAuley high school, Chicago, careful consideration was given to the design of the building as a multi-use structure, and to the expectation of varied heating requirements in different sections during separate time periods.

The structure includes a large rectangular central building housing a two-story auditorium, a cafeteria and adjacent kitchen and a one-story frontal area divided into a lounge and a main entry. It was anticipated that the lounge-entrance would be used from 8 a.m. to 10 p.m. six days a week, while the cafeteria would be occupied only from 11 a.m. to 1 p.m. The gymnasium would be in use from 8 a.m. to 3 p.m. on school days. Therefore, it was decided to zone these three areas separately.

Steam is supplied from a central plant at 110 psi through a 5 in. steel pipe underground supply main. Steam pressure is reduced to 5 psi for heating purposes, and is delivered to three-tiered finned radiation panels mounted beneath the high gymnasium windows, providing a maximum of unobstructed usable space. Two-position steam radiator valves with thermostatic control are provided for each radiator run.



HEATING ZONES in this Chicago high school are arranged according to hours of use for each of six separate areas

Steam is delivered to the cafeteria and associated kitchen and maids' quarters via an underground tunnel. Four-tier finned radiation panels with integral returns serve the cafeteria, with cabinet unit heaters installed in the kitchen near the ceiling. Semi-recessed convectors serve the maids' rooms. Because of the extreme variation in the hours of use, these spaces are individually controlled by thermostats.

Full-length windows in the lounge-entrance area dictated the use of floor panel radiant coils, with concealed cabinet heaters installed in the ceiling. An outdoor-anticipating central control valve is used, plus a thermostat-controlled on-off fan switch for the ceiling heaters.

Three two-story classroom wings on a canted axis extend to the East of the entrance building, with an opposed two-story wing housing faculty quarters at the rear. Offsets between the wing-sections contain a library and administrative offices.

The classroom wings, in use from 8 a.m. to 3 p.m. five days a

week, receive steam via corridor ceiling mains to four-tier radiation panels mounted along each exposed wall. One central control valve for each wing is supplemented by variable orifice valves to regulate the heat supply to each room. Automatic morning pick-up and night set-back is incorporated in the system.

The faculty quarters wing, with a community and dining room extension, is occupied continually. A two-pipe return system supplies hot water from a converter to semi-recessed convectors in each room, and to baseboard radiation units in the community and dining rooms. A central three-way control valve is installed for this zone, with a high-limit thermostat included. Individual convectors are equipped with manual control valves.

The library and administrative office block together comprise the sixth zone. In use from 8 a.m. to 10 p.m. six days a week, this section employs outside wall finned radiation panels in offices and corridors, plus cabinet unit heaters installed in the library bookcases. A central control valve with variable-orifice valves for each room allow for necessary adjustments.

Fox and Fox were the architects and engineers for the building and the design of the heating and ventilating systems.

Engineering Firm Tells Incorporation

THE former Washington State consulting engineering partnership of Bouillon, Griffith & Christofferson has announced incorporation of the firm as of March 14, 1960.

The officers and initial stockholders of the new corporation are Lincoln Bouillon, president, H. T. Griffith, vice president, L. F. Christofferson, treasurer, and R. H. Schairer, secretary. All four names are included in the corporate title.

Instrument Society To Feature Papers On Control Valve Problems

PAPERS discussing the problems of control valve selection and an approach to methods by which the size and performance characteristics of such valves may be determined and systems designed will be presented at a technical session on measurement and control instrumentation at the Instrument Society of America Summer Instrument-Automation Conference and Exhibit. The conference will be held May 9 through 12 in the San Francisco Civic Auditorium.

The papers to be presented are "*The Control Valve as a System Component*," by Jake E. Valstar, Hughes Aircraft Corp., "*Control Valve and Pump Design Based on Minimum Capital and Operating Cost*," by Marcus A. Roby and Herbert Simon of The Fluor Corp., Ltd., "*Progress in Steam Generator Control and Actuators for Nuclear Power Plants*," by M. J. Kimball, Kaiser Engineers, and "*Process Instrumentation for Organic Moderated and Cooled Nuclear Reactors*," by David J. Sabo, Atomics International Div., North American Aviation.

Other conference sessions will deal with air pollution instrumentation, data handling and computation, and physical and mechanical measurement instrumentation.

Approximately $1 million in products and services will be displayed during the exhibit, May 10-12 in Brook Hall, adjacent to the auditorium.

San Francisco was selected as the site of the forthcoming conference because of California's key position among the 11 western States, according to the society.

The first 1960 ISA conference was held February 1-4 in Houston, while the third will be presented in the New York City Coliseum, September 26-30, in conjunction with the society's 15th annual meeting.

New Grand Central City To Have 10,000 Ton Cooling Capacity

THE PROPOSED Grand Central City tower, to be built at the rear of the New York terminal, will embody record-setting features among the country's large office buildings, including a 10 to 11 million dollar mechanical equipment installation to heat and cool the tower's 2.4 million sq ft of tenant space.

The $100 million structure will rise 59 stories directly above the tracks and station platforms of the New York Central and New Haven Railroads, and its octagonal shape will present eight separate exterior exposures.

Three steam turbine-driven compressors with a total cooling capacity of 10,000 tons will be installed atop the roof of the structure because of the absence of underground space. 5000 peripheral high-pressure induction units will be supplied with 400,000 cfm from fans located on the 21st and 46th floors and on the roof. Interior areas will be conditioned by means of a two-zone system on each tower floor. Each zone will have a separate fan room to supply the area. Public service facilities in the building will be furnished with separate air conditioning units.

The installation is said to provide for a high degree of flexibility to meet the varying requirements of the building's tenants, including off-hour service, special heat-producing operations such as radio and television broadcasting, and the particular needs of electronic computing rooms and similar areas.

Raisler Corp. has received the mechanical contract for the building, completion of which is scheduled for late 1962. Jaros, Baum & Bolles, consulting engineers, designed the systems. Emery Roth & Sons, in association with Walter Gropius and Pietro Belluschi are the architects.

Steel, Wrought Iron Pipe Standard Revised

THE American Standards Association has announced approval of the latest revision of American Standard Wrought-Steel and Wrought-Iron Pipe, B36.10-1959. The standard is published by The American Society of Mechanical Engineers and co-sponsored by ASME and the American Society for Testing Materials.

The revised standard covers welded and seamless pipe of steel, wrought-iron, carbon steel and other alloys, but does not include tubing. A simplified format for tables of weights and dimensions including sizes and weights of American Petroleum Institute Standards 5L and 5LX is incorporated in the revision. The association states that decimal wall thicknesses and plain-end weights for some sizes of pipe vary slightly from those published in previous editions of the standard.

The new standard is available at $1.50 a copy from ASA at 10 E. 40th St., New York 16, or from ASME at 29 W. 39th St., New York 18, N.Y.

Revised Ventilation Manual Announced

THE Committee on Industrial Ventilation has announced the availability of the sixth edition of the Industrial Ventilation Manual.

The 1960 edition of the manual contains information on low volume high velocity systems, fan pressure-volume-horsepower curves, high and low temperature psychrometric charts, and a revised section on the testing of ventilation systems, new material on radiant heat, hood design diagrams, and a table of corrosion resistance properties of plastics.

The manual is available from the Committee on Industrial Ventilation at P.O. Box 453, Lansing, Mich., at $4 per copy.

Solar Cells Power Antique Electric Auto

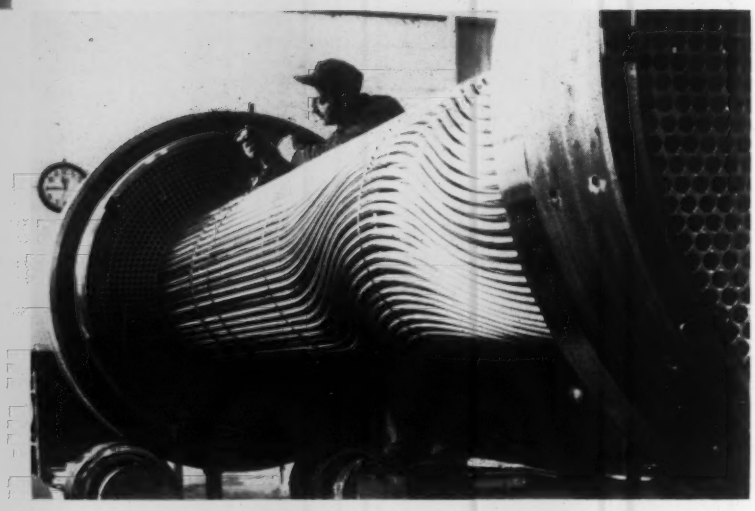
SILICON SOLAR CELLS, familiar as the paddle-wheel energy collectors for earth satellites, have been used to provide a source of charge to the batteries of a 1912 Baker electric automobile, demonstrated publicly for the first time by the International Rectifier Corp. at the recent American Power Conference in Chicago.

A 26 sq ft panel, containing 10,640 separately wired cells, is mounted atop the car's roof and connected to its drive batteries. According to Dr. Charles A. Escoffery, director of the project, the silicon cells can produce enough electricity in 8 hours sunlight to run the car for approximately 1 hour. The panel has developed a maximum test output of 115 v, 100 w at an efficiency peak of about 5 percent. The theoretical efficiency maximum of such cells is said to approach 25 percent.

Dr. Escoffery explained that the project was undertaken as a demonstration of the practical application of solar energy as a replacement for the world's rapidly diminishing supply of fossil fuels. The world's total recoverable supply of coal, gas, and oil power is said to constitute only about one-eighteenth of the estimated demands of the next century.

Nuclear energy, he said, offers a possible solution subject to several restrictions. Energy release by the process of fission, as is obtained in present day nuclear devices and power plants, requires expensive fissionable fuels, which are themselves subject to rapid depletion. The fusion process is to date perfected only to the extent that energy releases must be immediate and in huge quantities, as in the hydrogen bomb, and no breakthrough in the control of such a reaction is in sight. In either case, the amount of heavy shielding, precautions against radioactive contamination, and the problem of disposing of harmful wastes makes the nuclear power source awkward for the multiple small power demands of the world.

Dr. Escoffery stated that the sun delivers a million million kilowatts of energy to the earth each day, most of which is wasted. An energy collecting medium that operates even with a low efficiency factor may eventually provide an unlimited source of power with no waste other than excess sunlight, he said.



Atomic Heat Exchangers Use 19 Miles of Tubing

THREE intermediate sodium heat exchangers being built for the Enrico Fermi atomic power plant near Detroit will contain more than 19 miles of stainless steel tubing, according to Allegheny Ludlum Steel Corp.

The 130,000 lb units, largest ever built, will be more than 30 ft long and have a maximum diameter of 88 in., 16 in. of which will be shielding.

Liquid sodium will carry heat from the nuclear reactor to the heat exchangers, where a second sodium system will transfer the heat to a steam generator. A steam turbine will be connected directly to an electric generator.

Each stainless steel tube will be approximately 18 ft long, with a 7/8 in. OD. Tubes have been bent cold into a sine curve to accommodate differences in thermal expansion within the exchanger. The sine curve was substituted for the usual U-shaped tubes because of space limitations and the unique character of the heat transfer fluid. Tube bundles are removable for ease of maintenance.

Each of the exchangers is designed to transfer 489 million Btu per hr from the sodium coolant which flows from the reactor at a rate of 12,500 gpm at a temperature of 900 F. The primary coolant returns to the reactor at 600 F. Secondary sodium enters the 1860 tubes of each exchanger at 520 F and is heated to 820 F by the primary sodium. One reactor furnishes heat to all three exchangers.

Alco Products, Inc. is constructing the exchangers for Power Reactor Development Co.

Cites Cincinnati Air Pollution Control

ARNOLD ARCH, executive secretary of the Cincinnati Air Pollution Control Association, has credited that city's area-wide pollution control effort with a drop of 57 percent in the local soot-fall in the past 10 years.

Mr. Arch lauded Greater Cincinnati's "local" approach to the problem of pollution "because pollutants and other factors vary from city to city and each control program must be tailored to fit the local situation."

Central Station Systems Reach New High In 1959

THE INSTALLED cost of central station air conditioning systems placed in operation in large U.S. buildings for industrial and commercial use approximated $715 million in 1959, according to the Air-Conditioning and Refrigeration Institute. This figure was compared with a $604 million estimate for 1958.

The estimates are based on shipment reports for compressors, condensing units, absorption systems, and centrifugal and reciprocating liquid-chilling package units of 25 hp and over, but do not include figures for brine chillers or ammonia refrigerant equipment.

The institute estimates the refrigeration equipment cost of the installed systems at about 10 percent of the total, the remainder being expended on labor, ducts, insulation, controls, piping, and other installation costs. As in past years, large system installations accounted for the largest share of American air conditioning sales, according to ARI.

C.E.C. Releases Information Brochure

THE Consulting Engineers Council has recently made available an information brochure explaining the character and aims of the organization.

The booklet contains a short history of the organization, including a list of the regional and State associations affiliated with the national council, plus a report of accomplished and future projects. The council's Code of Ethics and Articles of Incorporation are also reproduced, together with adopted resolutions and policy statements, and a list of the committees presently in operation.

Copies of the brochure may be obtained from the council's executive secretary, Larry N. Spiller, at 326 Reisch Bldg., Springfield, Ill.

Big Fume Scrubber To Clean Gases at Rate of 42,000 Cfm

A HUGE fiberglas-reinforced polyester fume scrubber, constructed for an eastern metallurgical company, may be the largest single unit of plastic industrial equipment ever fabricated, according to Buffalo Forge Co., and du Verre, Inc.

Designed to handle dust-laden gases at the rate of 42,000 cfm, the scrubber is over 47 ft tall and has a maximum diameter of 10 ft. The scrubber will be equipped with more than 140 individual spray nozzles at the equipment site.

A second scrubber, 24 ft high and 5 ft in diameter, will control magnesium oxide and fluoride compound gases at the rate of 10,000 cfm. The two units will be served by 1000 ft of plastic ductwork.

Wisconsin University To Present Consulting Engineering Institute

THE THIRD ANNUAL University of Wisconsin Consulting Engineering-Management Institute will be held June 2nd and 3rd, 1960 at the new Wisconsin Center Building in Madison (see *Meetings & Conventions*, page 256).

The institute will include discussions on the organization, management, and financial spects of a consulting engineering firm, engineering contract documents, techniques of joint ventures, architect-engineer relationships, professional ethics, and the consulting engineers recommended manual of practices. Talks on these subjects will be presented by practicing consultants from many parts of the country.

Seminar sessions will be included in the meeting to enable registrants to explore in depth the material presented by the speakers, who will be present to answer additional questions.

Steel Mill Product Imports Exceed Exports in 1959

One Answer To Foreign Competition Is Harder Selling, Says Steel Executive

FOREIGN competition with the iron and steel industry of the United States was more intense last year than ever before, according to the American Iron and Steel Institute. For the first time since 1903, imports of steel mill products exceeded exports. The record flood of foreign steel imports entered the U. S. through every major customs district.

Total imports of steel mill products were 4,391,791 net tons in 1959, compared with 1,704,884 in 1958. Steel pipe and tubing imports last year were 553,135 net tons, and in 1958 they totalled 200,046 net tons. As some types of pipe are reported as structural material, it is believed, these figures do not represent all of the steel pipe that came into the country from foreign sources.

The figures for steel sheets are combined with strip, and cover hot and cold rolled materials. Last year, 332,933 net tons of hot and cold rolled sheet and strip were imported, compared with 26,969 tons in '58 — more than a twelvefold increase for imports of such materials.

The steel strike of course helped to raise the import total last year, although there is believed to be no official estimate of how much the strike affected the figures. However, the strike is not the explanation for the greatly increased tonnages the U.S. imported.

As has been pointed out by the AISI, many countries around the world have built or modernized their steel industries, and competition among world producers is keener than ever. About 50 countries have steel industries today, compared with some 25 countries back in 1934. The United States — top steel maker of the world — produced some 28 percent of the world output in 1958, compared with an average of 42 percent during the 1934-1958 period, says the Institute. Wages for foreign steelworkers, ranging from 66 to 86 percent below those of their American counterparts, are cited particularly by the AISI as important in the import situation.

Foreign steel will continue to be a factor in this country, it seems obvious, and Robert M. Buddington, sales vice president of Inland Steel Co., gave the reasons in a talk at the second Canadian-American trade and industry conference. They are, he said:

"1) Foreign producers have demonstrated their ability to undersell American steel by as much as 15 to 20 percent.

"2) Some foreign producers will export if necessary at any price because the political atmosphere in which they operate makes for a high degree of inflexibility with respect to labor costs.

"3) They continue to expand their steel capacity with modern facilities — it is forecast that Western Europe's capacity will grow 28 percent between 1959 and 1965.

"4) Their quality of steel has improved with their newly-built modern facilities.

"5) They are adopting more aggressive marketing tactics. American subsidiaries are being established and foreign steel depots and warehouses are being provided.

"6) Probably as a summary of the future — they must export to live and to grow and they are skilled and determined to do both.

(*Continued on page 42*)

Belgium, for example, has been the chief source of foreign steel into this country. Exports normally account for two-thirds of this country's entire steel production.

"I am therefore forced to conclude," he said, "that foreign steel competition will be a permanent factor in our steel using markets."

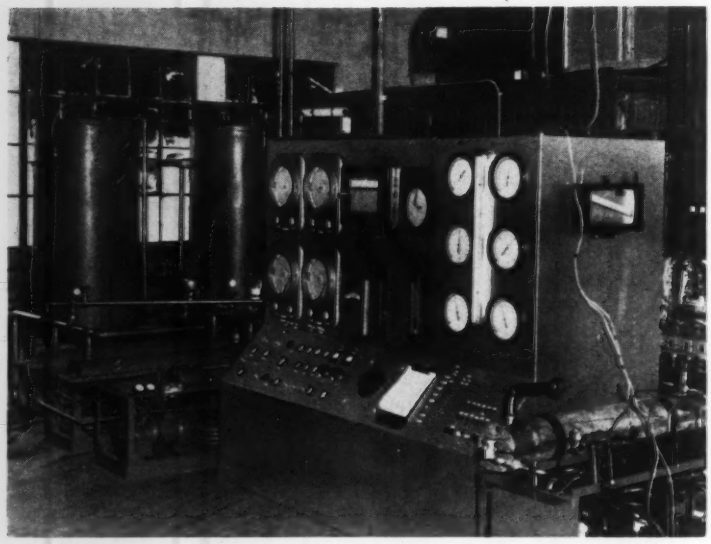
For the U. S. steel industry to meet foreign competition, Mr. Buddington said that our government should continue to urge foreign governments to remove discriminatory resirictions against American exports. We should be on an equal footing with other industrial nations of the world, he stated. For example, in the case of steel, our tariff restrictions are minor, he said. And in the broadest view, our government should continue to urge the other now economically strong nations to shoulder their share of the aid for the under-developed countries, he said.

While these are perhaps things that our government can help with, there are also many others that we can do ourselves, said Mr. Buddington, one of the first being to develop a greater awareness of foreign trade.

The American steel industry should continue to accelerate research and development towards improved and specialized steels and more efficient facilities, Mr. Buddington said, and obviously must keep costs and selling price as low as possible, "for while price is usually not the only reason for buying, in a free society it is still an important one."

And the steel industry can sell harder, he said. Better service, closer communications, personalized selling, more accurate specifications, better technical assistance — these are things that can be improved at home and maybe even sold abroad, he stated.

In many ways the problem of foreign competition is really the problem of effective competition in general, he concluded. "To the degree that we constantly strive to serve the needs of our customers and provide a quality product at the lowest possible price, we will most effectively meet competition from outside as well as within. It can be the type of fair, aggressive competitive battle that we in this country always claimed we were good at and enjoyed," he said.



Calorimeter Room Provides Test Environment for Air Conditioning Units

AIR CONDITIONING units designed to provide stable environmental conditions for areas surrounding modern electronic computing units, now in use throughout the world, must be themselves capable of providing dependable service under a wide variety of changing temperature and humidity combinations. Normal demands on such equipment may be far exceeded when units are installed in tropic or near-arctic regions, yet today's complicated electronic brains must be protected in a stable atmosphere under many temperature-humidity extremes.

To provide these extremes for test purposes before the various units are shipped, Therm Air Mfg. Co. recently built a special calorimeter room on the plant site at Peekskill, N. Y., large enough to accommodate the largest unit manufactured there. Within this room any anticipated climatic condition expected in the field can be duplicated, within the range of 20 to 140 F with a relative humidity from 10 to 99 percent. Supplemental air conditioning equipment can be connected to increase the temperature range from 20 to 160 F.

Pneumatic controls regulate the closed circuit chilled water cooling system, and provide automatic mixing of the chilled water with 170 F water when heating is required. Hot water requirements are met by a 99,000 Btu per hr gas fired steam boiler. Other pneumatic controls operate and indicate the dry bulb and wet bulb temperatures.

Operation of the calorimeter room has indicated that temperatures may be maintained to a tolerance of ± 0.5 F, according to the American Gas Association.

IT MAKES SENSE !

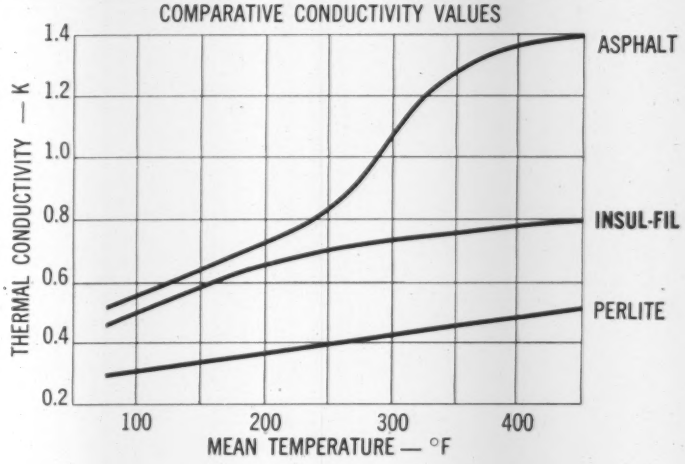
TO INSULATE UNDERGROUND PIPING WITH

insul-fil®

1 Introduction of a material such as expanded perlite into a granulated hard asphalt improves the insulating value of the blend.

2 Proper selection of asphalts by softening point to make up asphalt-perlite blends improves the insulating properties of the blend.

3 Introduction of an aggregate, such as perlite, into a granulated asphalt improves the mechanical properties of the blend once it is plasticized.



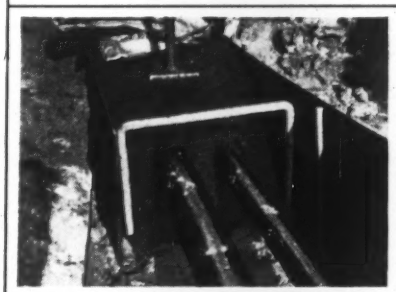
After years of extensive testing conducted at the Research and Development Department of The Atlantic Refining Company, these conclusions were presented in a Paper given before the American Chemical Society in Dallas, Texas, April, 1956. Since that time, hundreds of Insul-fil field installations have confirmed these conclusions.*

It is a well-known fact that the use of asphalt in construction created the necessity for the introduction of fillers (usually inorganic) of various types for the purpose of arresting the flow characteristics and improving the insulation value of the asphalts themselves.

The blend of hard granular asphalt and asphalt coated perlite gives Insul-fil its excellent insulating properties, water resistance and sufficient structural strength to the insulating body to resist normal soil stresses with the steam on or off.

An important Insul-fil development is the priming of the pipe with Accelerator #7591. The use of accelerator provides continuous adhesion of Insul-fil to the pipe, hastens consolidation, and gives additional protection against corrosion by galvanic action.

**Paper available on request.*



Insul-fil Is Simple To Install

Just pour it around the pipe to be insulated. Prod and tamp it in place and backfill. Heat introduced into the pipe forms the conduit.

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freezing

space

maintenance

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CASINGS
Selection of material to fit Architectural treatment and surrounding conditions.

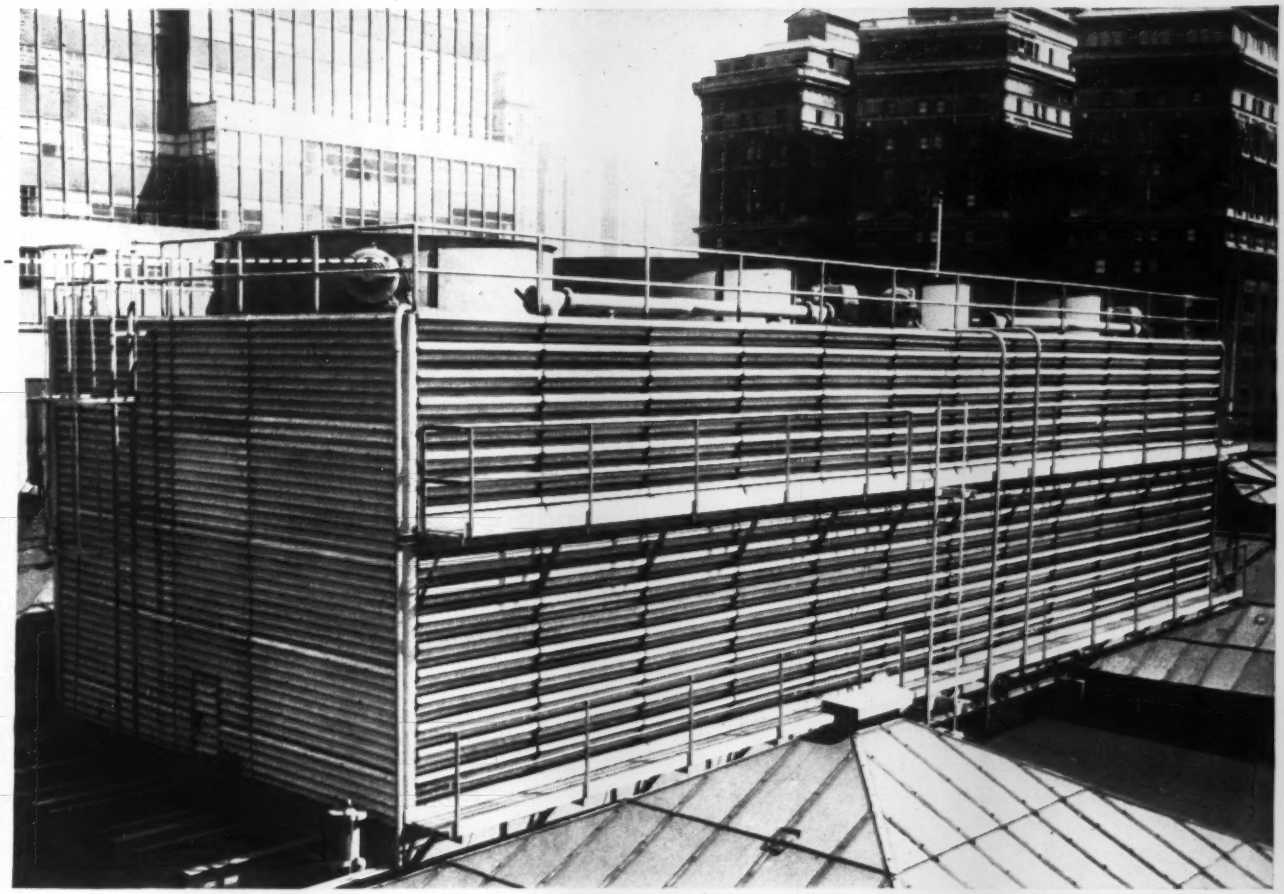
BASINS
Redwood, stainless steel, galvanized steel, carbon steel up to and including ¼" thickness with any desired coating, reinforced concrete basins supported on steel beams.

DISTRIBUTION SYSTEM
Spray nozzle type or open Weir gravitational type system.

FANS
Multi-blade, adjustable propeller type fan in cast aluminum, stainless steel or Monel. Either direct driven fan in small sizes or indirect right angle worm gear drives.

FILL
Redwood or pressure treated Douglas Fir. Slip-fit, self-supporting for easy removal for interior maintenance.

FRAMEWORK
Hot dipped galvanized structural steel .250" minimum thickness. Redwood or pressure treated Douglas Fir.



GIMBEL'S DEPARTMENT STORE, New York City
Consulting Engineer: Charles S. Leopold, Philadelphia, Pa.

another problem solved by Phillips CUSTOM ENGINEERED COOLING TOWERS

the problem:

To provide a cooling tower as free from maintenance as possible and yet perform efficiently in the limited area.

the solution:

PHILLIPS CUSTOM ENGINEERED COOLING TOWER with "Dual-Airstream" design, modified to provide accessibility under fill. Hot dipped galvanized framework field-coated with butyl rubber to further improve service life. Walkways provided at two levels for easy inspection and maintenance.

result:

A trouble-free cooling tower that provides maximum efficiency for one of the world's largest department stores.

SPECIAL FEATURES ON ALL TOWERS

Corrosion Resistant Hardware. Aluminum or Stainless Steel Fans. Nailless Redwood Filling Removable at Tower Base. Nailless Three-Pass Redwood Eliminators. Removable Louvers.

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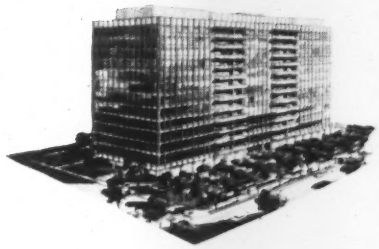
14 1/2" LOW!

NEW MODINE FAN-COIL UNITS PERMIT FULL-ROOM DECORATING

IN BUILDINGS WITH CURTAIN WALLS

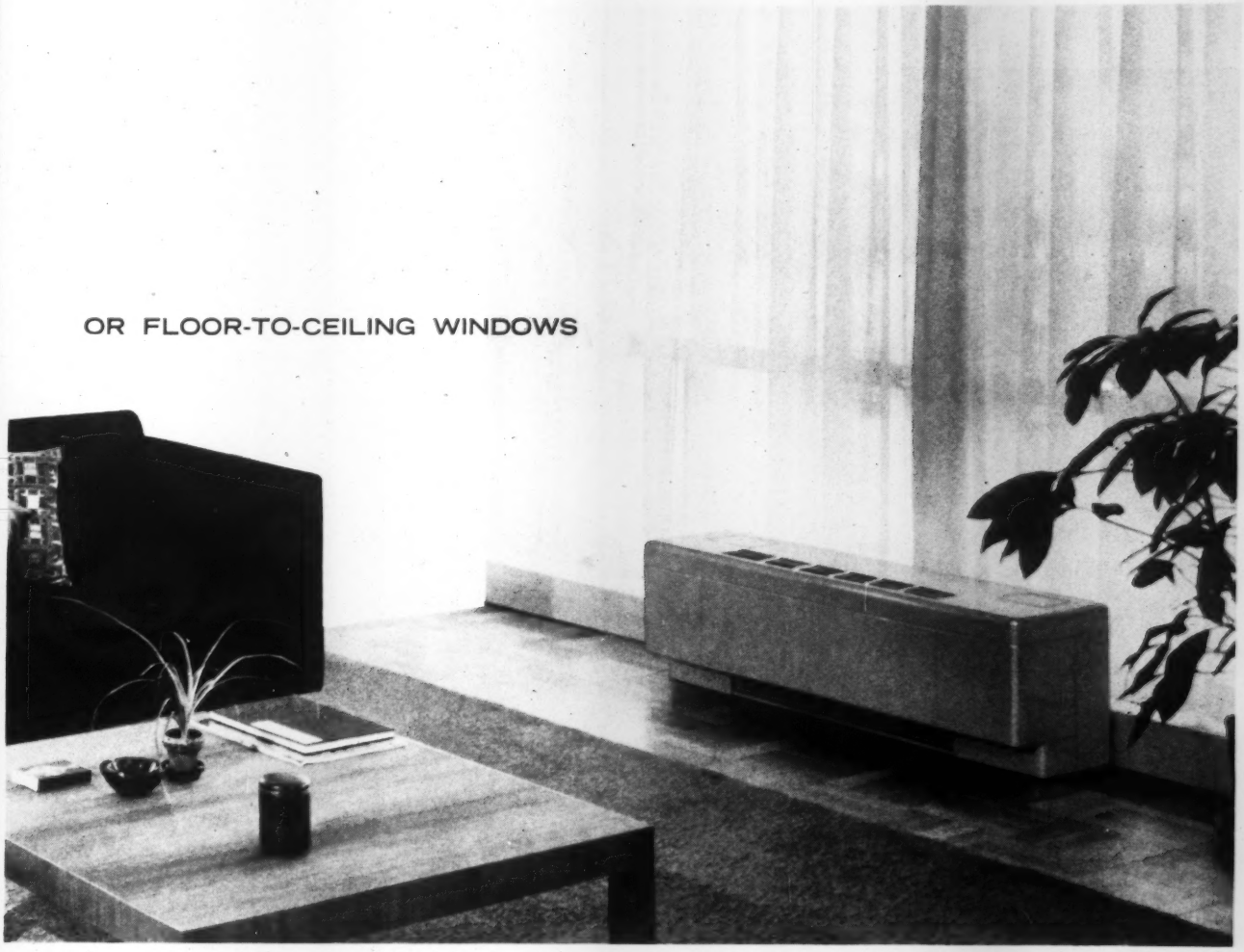
MODINE LOW-BOY *Airditioners*®

Special, nonstandard adaptations of the Low-Boy AIRditioner include provision for above-the-floor concealment of supply and return piping and for uninterrupted wall-to-wall installations. Because quantity, delivery and price are determined on an individual basis, please contact your Modine sales representative or write to the company.



550 LOW-BOYS IN LAKE MEADOWS 600—Modine Low-Boys are providing year-round comfort for residents of Chicago's newest luxury apartment building . . . Lake Meadows 600. This gleaming, glass-enveloped, 12-story and penthouse building overlooks Lake Michigan . . . contains 140 apartments. Owners: New York Life Insurance Co.; Architects and Engineers: Skidmore, Owings & Merrill; Mechanical Contractor: Advance Heating & Air-Conditioning Corp.; General Contractor: Turner Construction Co.

OR FLOOR-TO-CEILING WINDOWS



Modine Low-Boys are never in the way . . . of architect, decorator or tenant. They crouch close to the floor as they heat, cool, filter and dehumidify. The 14½" height is almost a *full foot lower* than other fan-coil units. Although midgets in size, Low-Boys are giants in performance. Using hot or chilled water from a central source, they deliver year-round comfort . . . quietly, economically. They're individually controlled thermostatically or manually. And response is instantaneous!

Handsome Low-Boy enclosures blend with the decor of any room. They're available in 44-, 52-, 68- and 96-inch lengths . . . in six decorator colors: ivory, putty, rose beige, sepia, almond green and dark jade green. Bulletin 760B has complete Low-Boy details. The coupon will send your copy on its way.

A-1411

Modine
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Please send new Low-Boy Bulletin 760B.

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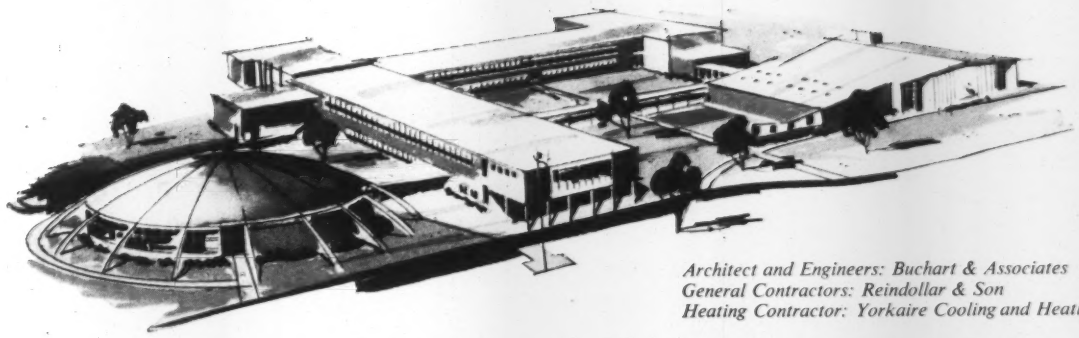
In Canada: Sarco Canada, Ltd., Toronto 8, Ontario

Mr. Curtis A. Botts—heating and ventilating contractor for the new Hannah Penn Junior High School, York, Pa., says:

"Working with Honeywell, and finished

Mr. Curtis A. Botts, President of the Yorkaire Cooling and Heating Company, in one of the Honeywell-controlled classrooms at Hannah Penn Junior High School. For excellency of design, this beautiful new school was awarded a certificate of merit by the American Society of Registered Architects.

we started the job on time."



Architect and Engineers: Buchart & Associates
General Contractors: Reindollar & Son
Heating Contractor: Yorkaire Cooling and Heating Co.

Trained Honeywell specialists helped keep Hannah Penn school on schedule, supervising the temperature control system during planning, installation and checkout.

"Honeywell's trained specialists helped us avoid costly delays," says Mr. Botts. "They turned in clear shop drawings of the temperature control system. They helped speed up equipment deliveries. They gave us good supervision during installation, then checked out the entire system. As a result, we started on time, and *stayed* on time until the job was finished."

The result for this handsome new school is an efficient, smooth-working temperature control system with wall-mounted classroom thermostats—a system that assures an indoor climate ideal for better teaching, better learning.

If your next job calls for a temperature control system by Honeywell, you'll get all the help you need from skilled, efficient specialists—help that saves you money, time and worry. Get the whole story; call one of the 112 Honeywell sales and service offices nearest you. Or write Honeywell, Dept. AC-5-75, Minneapolis 8, Minn.

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First in Control

SINCE 1885

The Honeywell Round Thermostat—famous symbol of quality temperature control

75 YEARS PIONEERING THE FUTURE

Now—a new appearance concept for low-budget commercial installations

The "Power-Plant" Look

with Johns-Manville FIBROCEL Insulation!

Now you can bring the traditionally fine appearance and performance excellence of your power plant work to general commercial and industrial installations... with Johns-Manville Fibrocel® Insulation!

Why these power plant advantages? Simply because Fibrocel is molded! The only commercial insulation made (by a precision metal mold) to near-perfect roundness, with unmatched uniformity of size and line.

This means an immediate end to costly finishing, heavy jacketing, needless pointing up of cracks and apertures. Instead, Fibrocel gives you a tighter, better looking installation just as it is applied. Pipelines are gun-barrel straight, firm end to end. The look of a power plant!

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Let us send you the informative new brochure, IN-155A. It gives you full details on Fibrocel's thermal performance. Illustrations show why Fibrocel installs easier . . . takes abuse, too. Keeps its fine appearance and performance excellence for the life of the installation. Write for it today!

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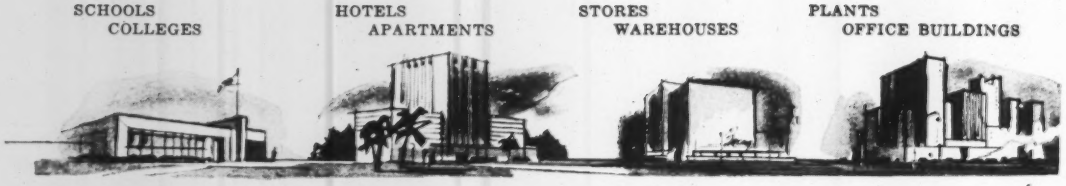
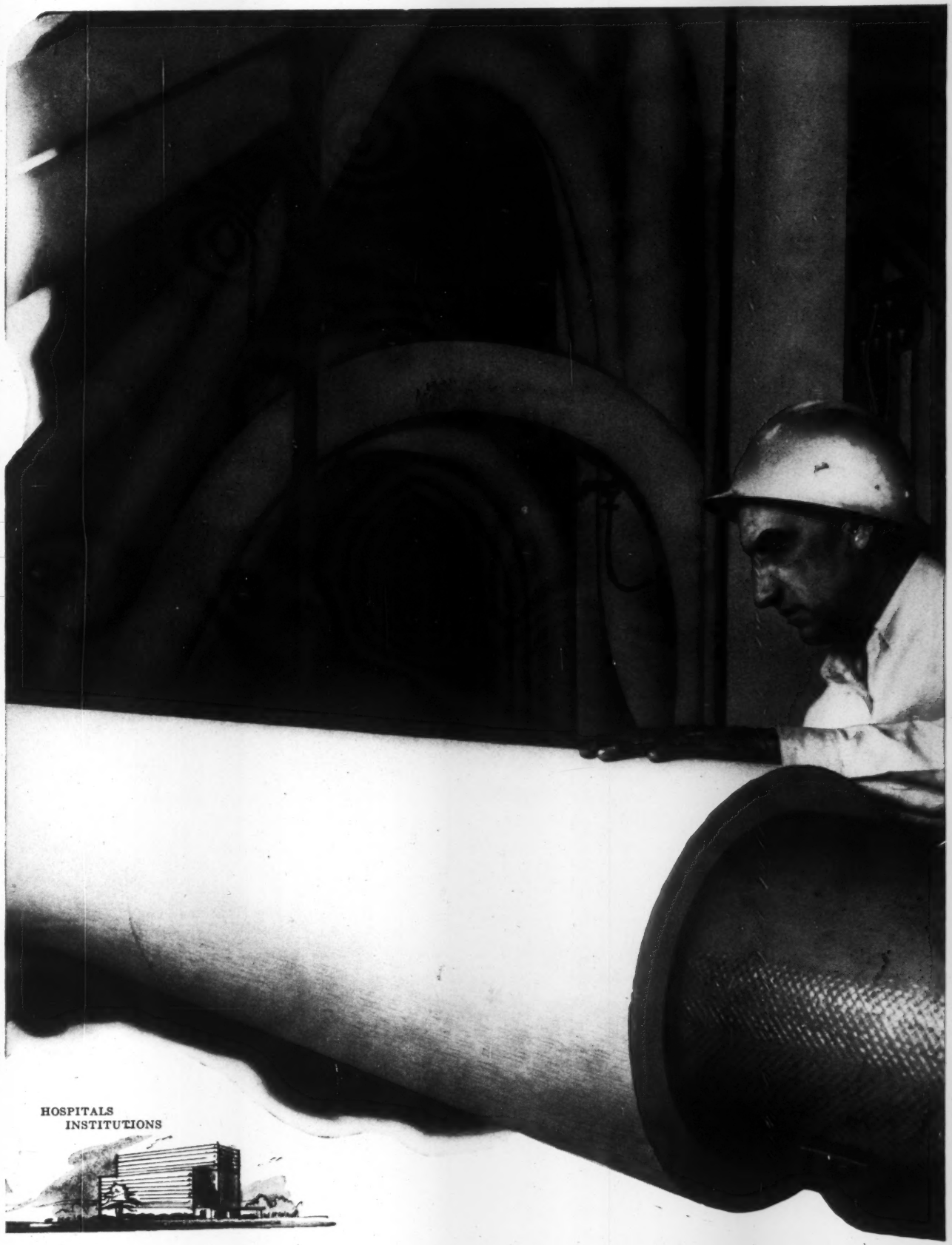
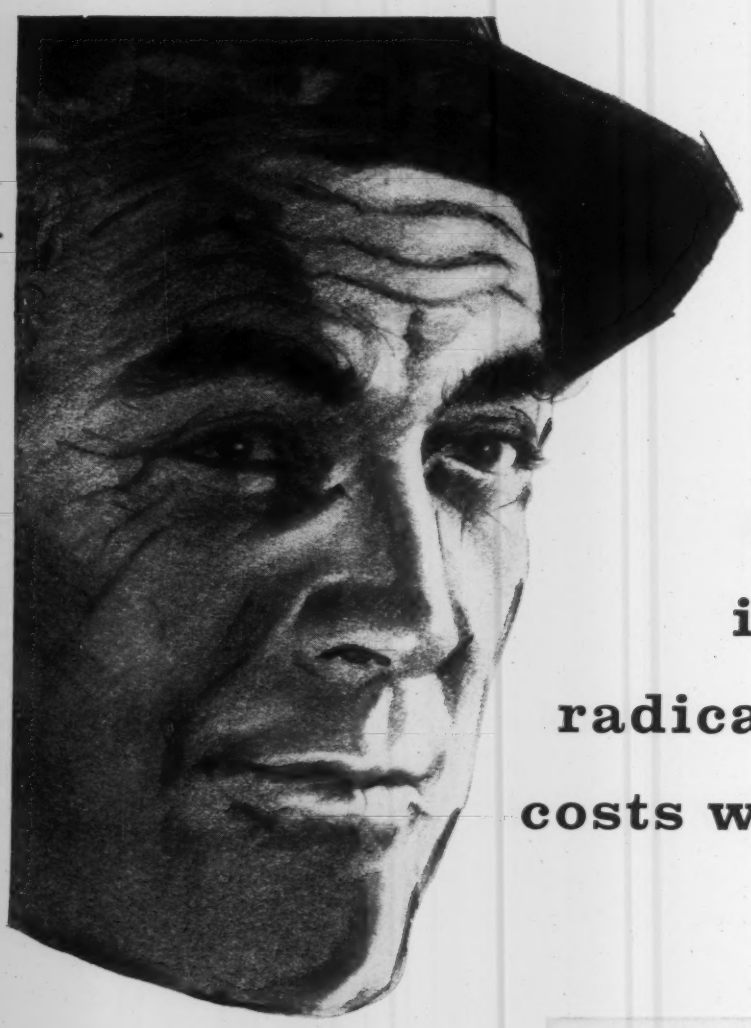
...Specify Fibrocel for the "POWER PLANT" look in installations like these (35F to 300F)




HOSPITALS
INSTITUTIONS



Look at how contractors are speeding installations, radically reducing costs with Greenlee

JOB–

As the bidding gets tighter and the profit squeeze grows tougher, today's smartest contractors are "tooling up" in every practical way to streamline operations — and to *control* costs!

Many are finding the answer in *Job-Profit Tooling* by Greenlee. It mechanizes much of the work previously done by hand, saves costly materials — assures extra efficiencies, better final results, *more net profit per job!*

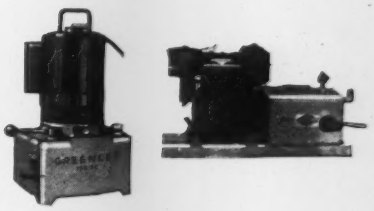
To illustrate — the Greenlee Lightweight Hydraulic Pipe Bender at right makes a 90° bend in 3" pipe in approximately one minute, with *one ram stroke.* Models available for making any bend up to 90° in ½" - 2"; ½" - 3"; ½" - 4"; and 1¼" - 6" pipe. Attachments available for bending steel, copper, brass, and aluminum tubing. See facing page for other ways to save time, cut costs with Greenlee Job-Profit Tooling.

For fast installation of underground pipe

With a Greenlee Hydraulic Pipe Pusher on the job you quickly, easily push pipe underground . . . without tearing up pavement, sidewalks, tracks, floors, lawns. Eliminates extensive trenching, tunneling, backfilling and repaving. Just a short trench accommodates the pusher to save you hours of excavating work. Greenlee Hydraulic Pipe Pushers are extensively used to make underground installations of pipe for gas, water supply, industrial processes, and other purposes; conduit for electricity and telephone cable. Many owners report that this equipment often pays for itself in labor savings alone on the first few jobs.

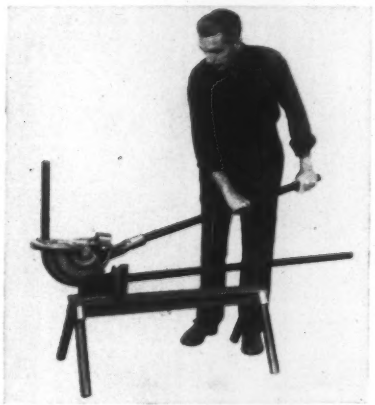
Pipe Pusher No. 790 for ¾″ - 4″ pipe sizes. Six speeds, up to 40 tons pushing pressure. Average pushing speed 2 feet per minute when equipped with No. 797 power pump.

Pipe Pusher No. 795 for pipe larger than 4″, concrete sewer and corrugated drainage ducts. Six speeds, up to 75 tons pushing pressure. Both models can be operated with hand or power pump.



For faster operation of pipe benders, pushers — Convert from hand to power pump. Many contractors are finding the value of power operation over their previous hand-operated equipment. Power pumps increase pipe bending speed from 3 to 5 times, proportionally increase pipe pushing speed. A complete line of Greenlee hydraulic power pumps available with electric motors or gasoline engines — in various models to meet your job requirements — all with 10,000 psi maximum pressure. Illustration above (left) shows the popular Greenlee No. 798 AC-SA pump with ¾ hp, 110-220 volt a-c electric motor. (Right) No. 797-G-SA pump with 4½ hp gasoline engine. Also available with rubber-wheeled undercarriage.

PROFIT TOOLING



For bending small pipe — New Greenlee Ratchet Benders speed and simplify bending of pipe (½″ - 1½″) with ratchet action that permits short, powerful strokes. Makes any bend up to 90° and is equipped with built-in bending gauge, 0° to 90°. Swing-away pipe clamp permits fast, easy loading. Can be operated on its T-iron base or equipped with standard pipe legs as shown at left. Two models: No. 1800 for ½″, ¾″, 1″ pipe, No. 1801 for 1¼″, 1½″ pipe.

Also available from Greenlee, hand benders for fast, easy bending of copper, brass, and aluminum tubing. Copper tube benders make bends up to 90°. Tubing and pipe benders make bends up to 180°. Various models and sizes.

For boring pipe-size holes —Greenlee multispur bits bore holes in wood for following sizes of pipe: ½″, ¾″, 1″, 1¼″, 1½″, 2″. Use with power drill or bit brace. Sets of six packed in metal box.

Write for new illustrated quick-reference Bulletin E-240.

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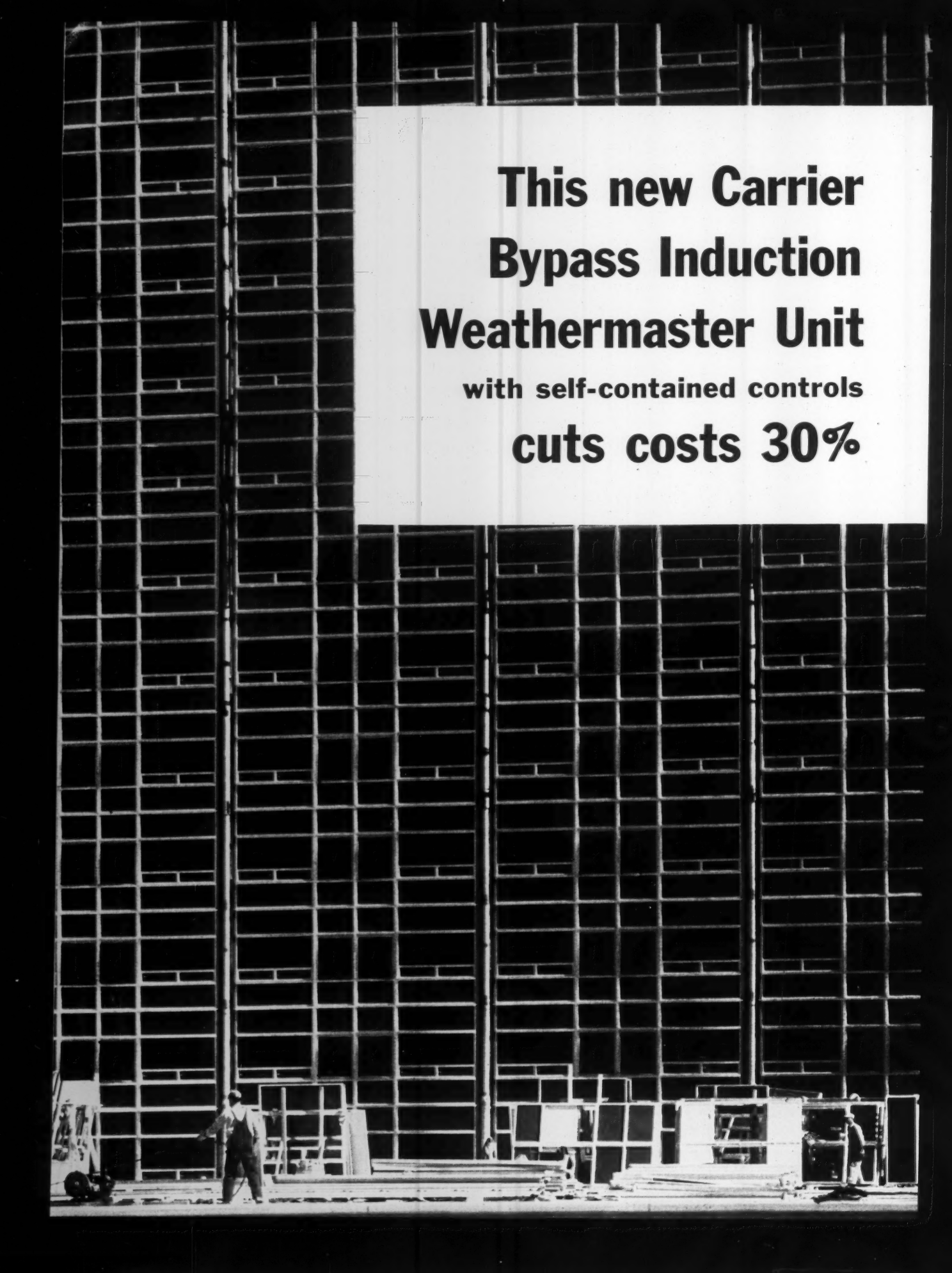
JOB-PROFIT TOOLING

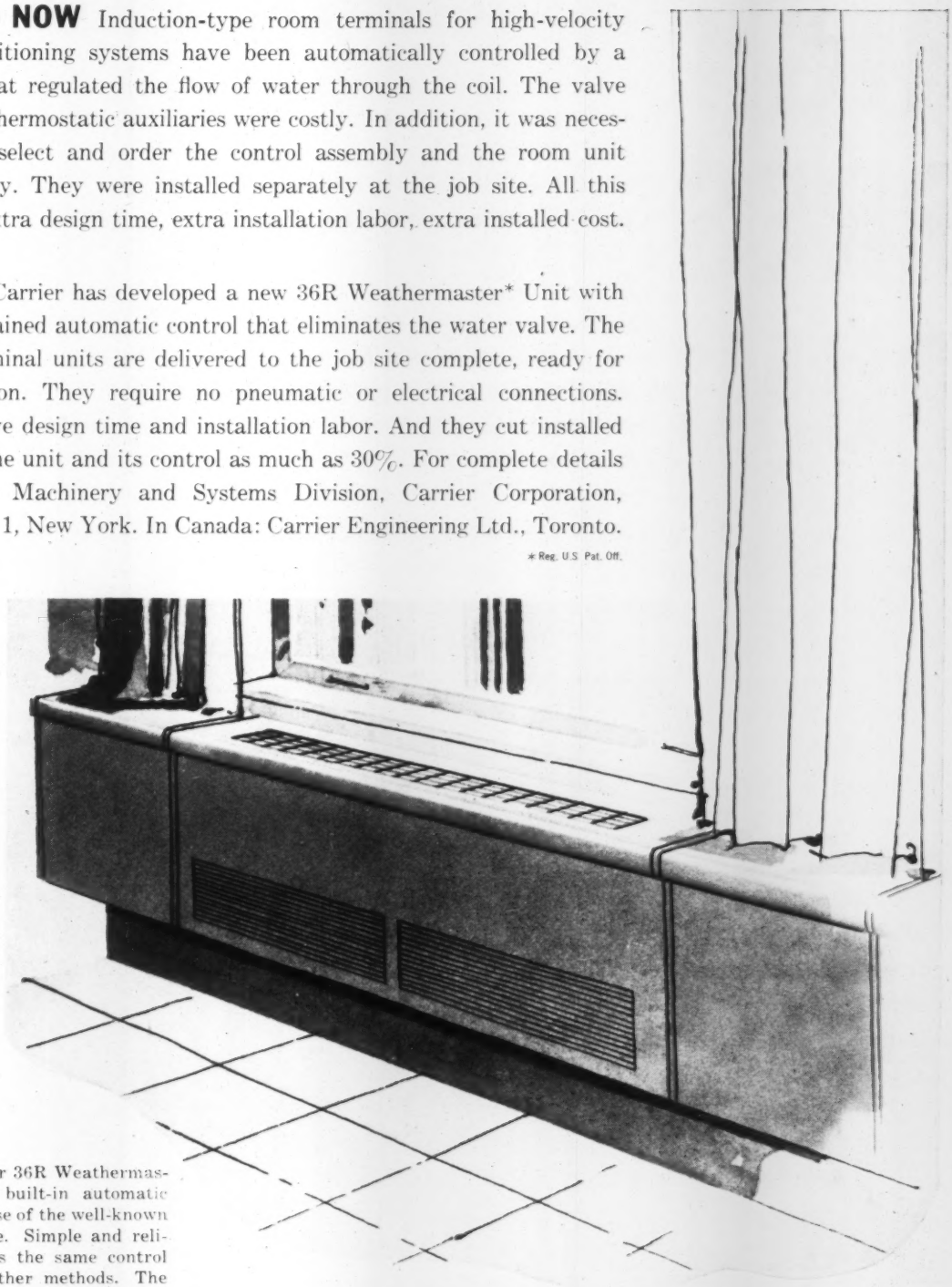
. . . cost control for contractors


This new Carrier
Bypass Induction
Weathermaster Unit
with self-contained controls
cuts costs 30%

UP TO NOW Induction-type room terminals for high-velocity air conditioning systems have been automatically controlled by a valve that regulated the flow of water through the coil. The valve and its thermostatic auxiliaries were costly. In addition, it was necessary to select and order the control assembly and the room unit separately. They were installed separately at the job site. All this meant extra design time, extra installation labor, extra installed cost.

NOW Carrier has developed a new 36R Weathermaster* Unit with self-contained automatic control that eliminates the water valve. The new terminal units are delivered to the job site complete, ready for installation. They require no pneumatic or electrical connections. They save design time and installation labor. And they cut installed cost of the unit and its control as much as 30%. For complete details write to Machinery and Systems Division, Carrier Corporation, Syracuse 1, New York. In Canada: Carrier Engineering Ltd., Toronto.

* Reg. U.S. Pat. Off.



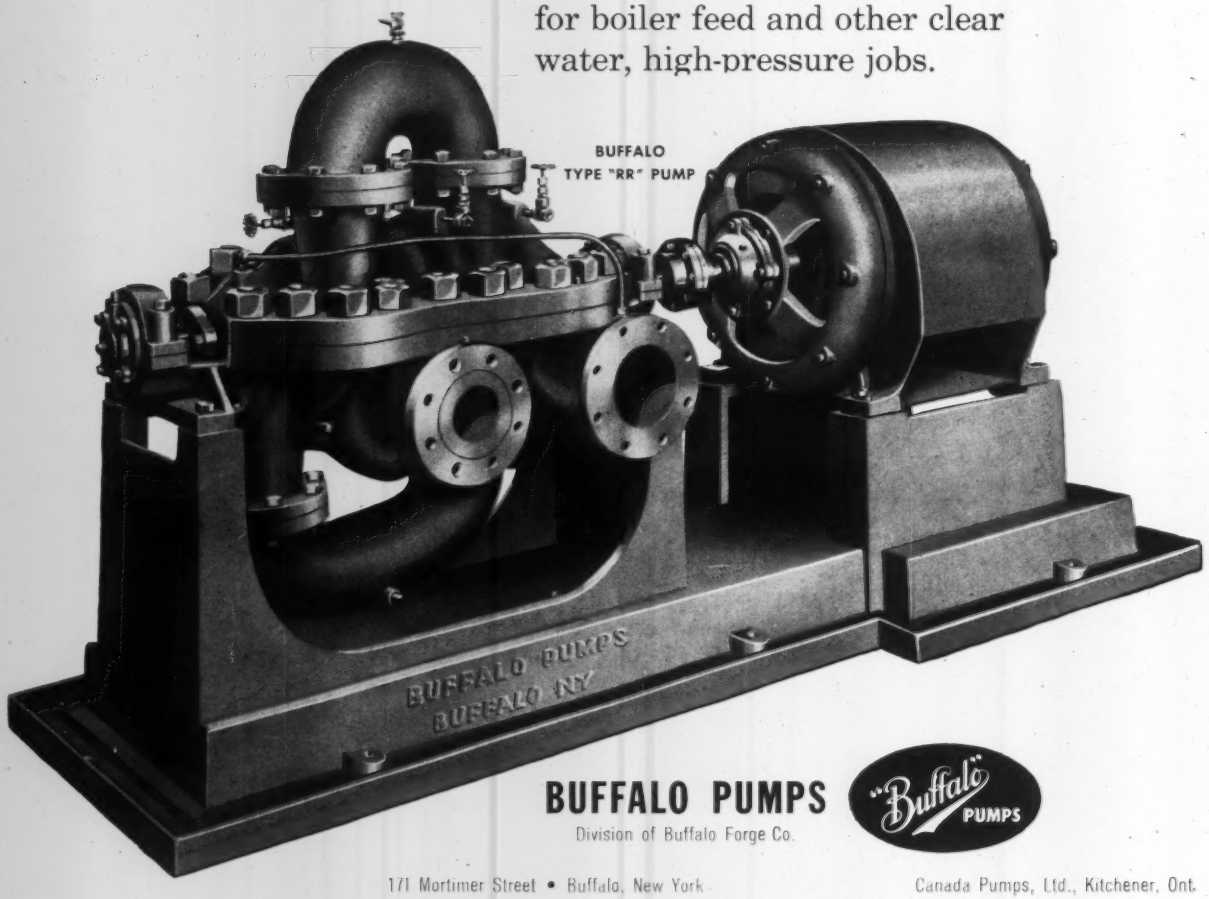
The new Carrier 36R Weathermaster Unit with built-in automatic control makes use of the well-known bypass principle. Simple and reliable, it provides the same control versatility as other methods. The units are available with cabinets or for furred-in applications.

MORE PROOF OF
BETTER AIR CONDITIONING FOR EVERYBODY EVERYWHERE

Carrier

HIGH PRESSURE PUMPING

WITHOUT SACRIFICING EFFICIENCY! Write for Bulletin 980 and see how Buffalo combines efficiency with rugged strength in these 2 and 4 stage pumps for boiler feed and other clear water, high-pressure jobs.



BUFFALO PUMPS
Division of Buffalo Forge Co.

"Buffalo" PUMPS

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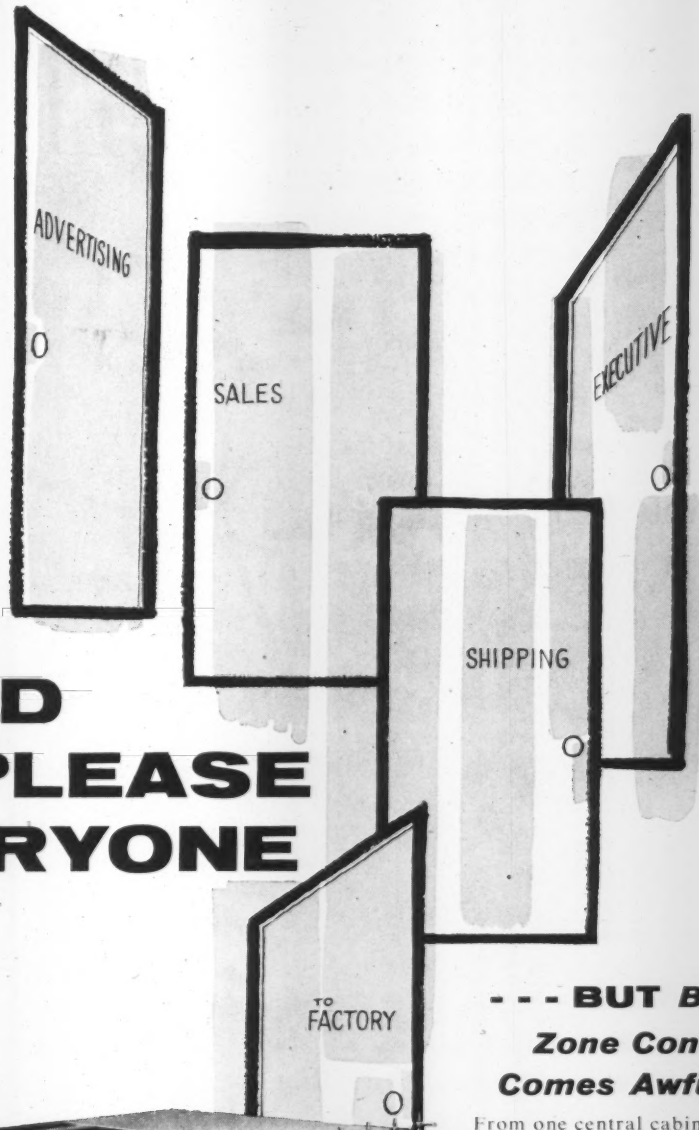
A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



IT'S HARD TO PLEASE EVERYONE

- - - BUT *Buffalo Zone Conditioning Comes Awfully Close!*

From one central cabinet here's individual year 'round comfort conditioning to suit **many** different areas of a building. Each zone is controlled automatically. Consider these exclusive *Buffalo* features:

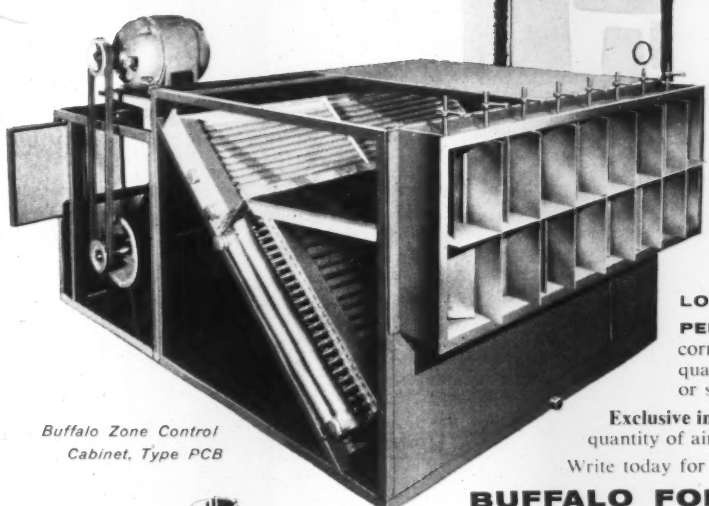
RUGGED TUBULAR FRAME — easily assembled and installed. Convenient to service thru handy access doors, removable panels and outside bearings.

CHOICE OF COMBINATIONS — floor or suspended mounting arrangements — any combination of heating, cooling or humidity control.

LOW HEAD ROOM due to 45° pitched coils.

PERMANENCY—DEPENDABILITY — heavy-gauge, corrosion-resistant paneling, coils, pans and dampers; high-quality backward curved limit load fans; heavy-duty ball or sleeve bearings.

Exclusive individually sized damper zones to accurately proportion quantity of air flow.



Buffalo Zone Control Cabinet, Type PCB

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Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

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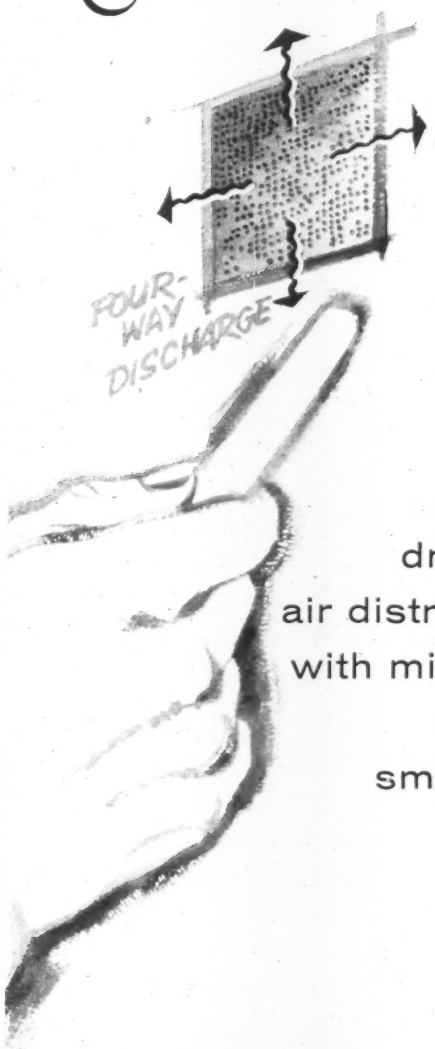
The air

ONE-WAY DISCHARGE
TWO-WAY CORNER DISCHARGE
TWO-WAY OPPOSITE DISCHARGE
THREE-WAY DISCHARGE

Recessed type
Surface type

Air pattern control plates can be installed on the job or at the factory.
Diffuser plate removable to provide vertical discharge.

goes where you want it

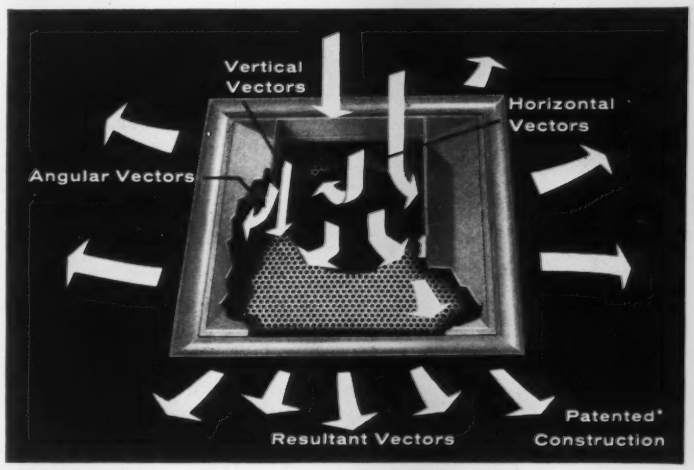


. . . with the original square perforated face diffuser

Uni-Flo square and rectangular ceiling diffusers with perforated faceplates provide a high rate of aspiration and great flexibility to meet the requirements of modular construction or any arrangement of partitions.

The air pattern can be adjusted on the job for vertical or horizontal deflection, and for one-, two-, three-way, or 360° discharge without altering the appearance.

Quiet, draftless air distribution with minimum ceiling smudging



These attractive units are inconspicuous and blend well with all types of ceiling construction; the engineered air flow minimizes ceiling smudging.

Patented* design assures low pressure drop for draft-free comfort at very low noise levels. Imitated by many but unequaled in performance. Available in recessed or surface-type units for all types of acoustical, plastered, or metal pan ceiling applications. Complete performance data available . . . guarantees job performance.

For complete information, call your local Barber-Colman Air Distribution field office or write for Catalog No. F-6597-2.

Also available with factory-built hinged assembly for control of room coverage.

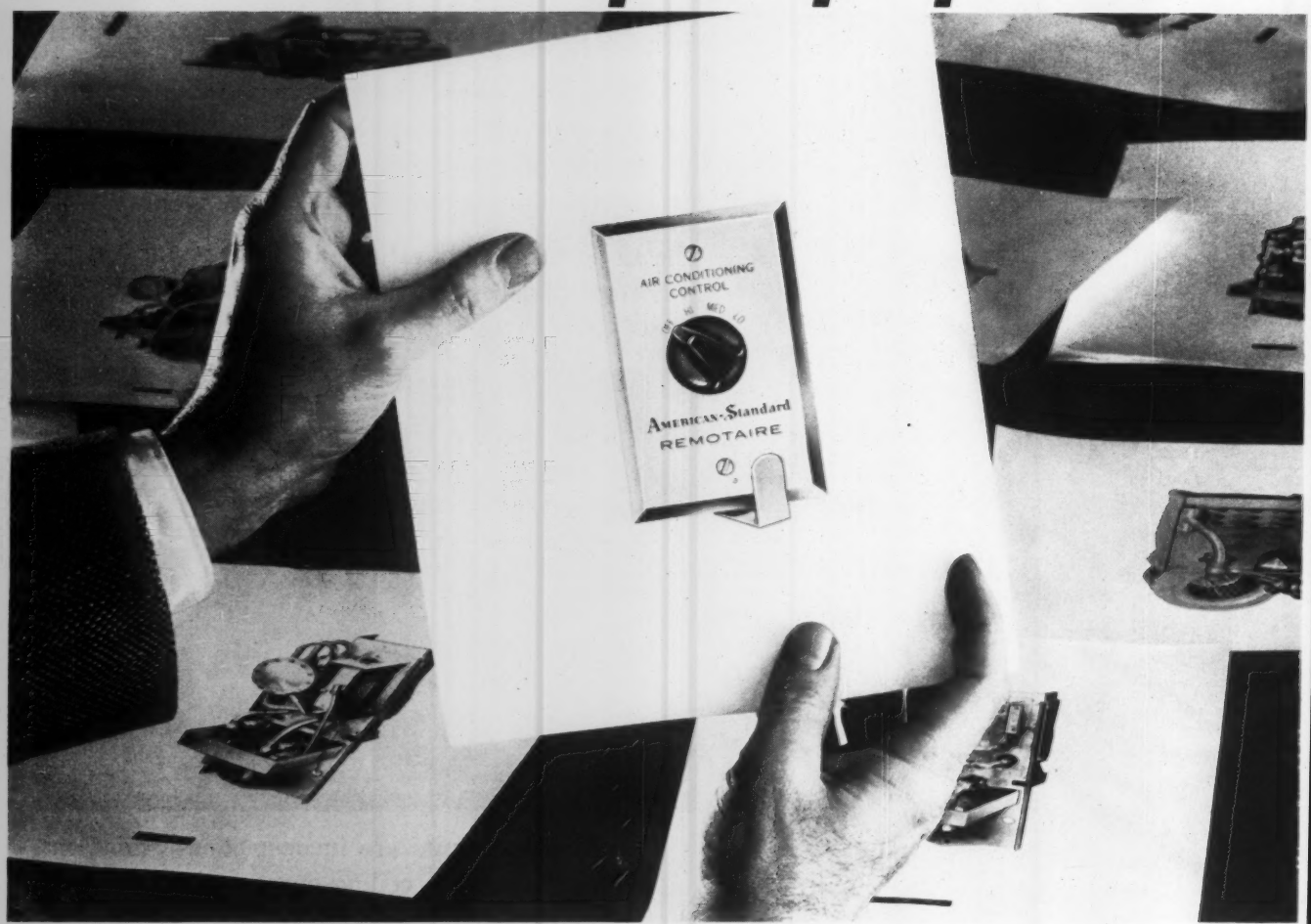
BARBER COLMAN

*Patent No 2821891

BARBER-COLMAN COMPANY

Dept. E, 1101 Rock Street, Rockford, Illinois

See how many ways you can



American-Standard offers you a choice of more than 17 packaged control arrangements for the Type 20 Remotaire (vertical units); 11 for the Type 30 (horizontal units).

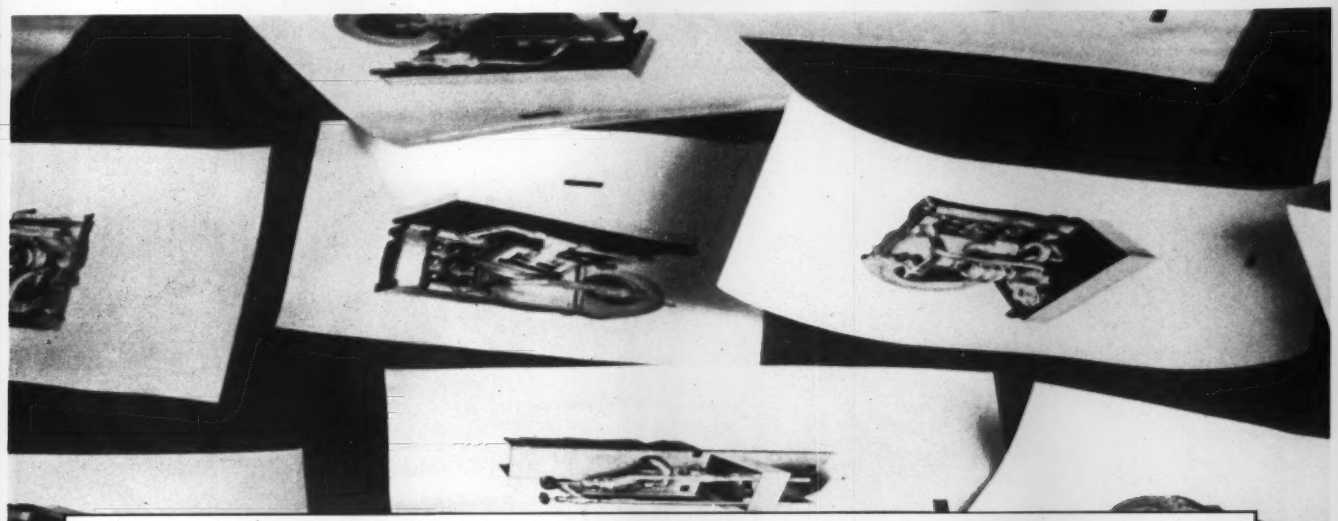
Truly personalized selection of air and water flow control is outlined in the accompanying table of components and operation in four categories—manual, electric, pneumatic and self-powered.

Test-rated Remotaire units are part of a hydronic* system, for year 'round air conditioning. Control packages, boilers, water chillers, and convectors and baseboard heating panels (for bathrooms and kitchens) are all available from American-Standard in a variety of styles and sizes for exact satisfaction of individual installation and application requirements.

For complete information about Remotaire installation, application and *control*, contact an American-Standard representative or write: AMERICAN-STANDARD, PLUMBING AND HEATING DIVISION, 40 W. 40th Street, New York 18, N. Y.

**Hydronics—the science of heating and cooling with water.*

CONTROL FAN COIL UNITS!



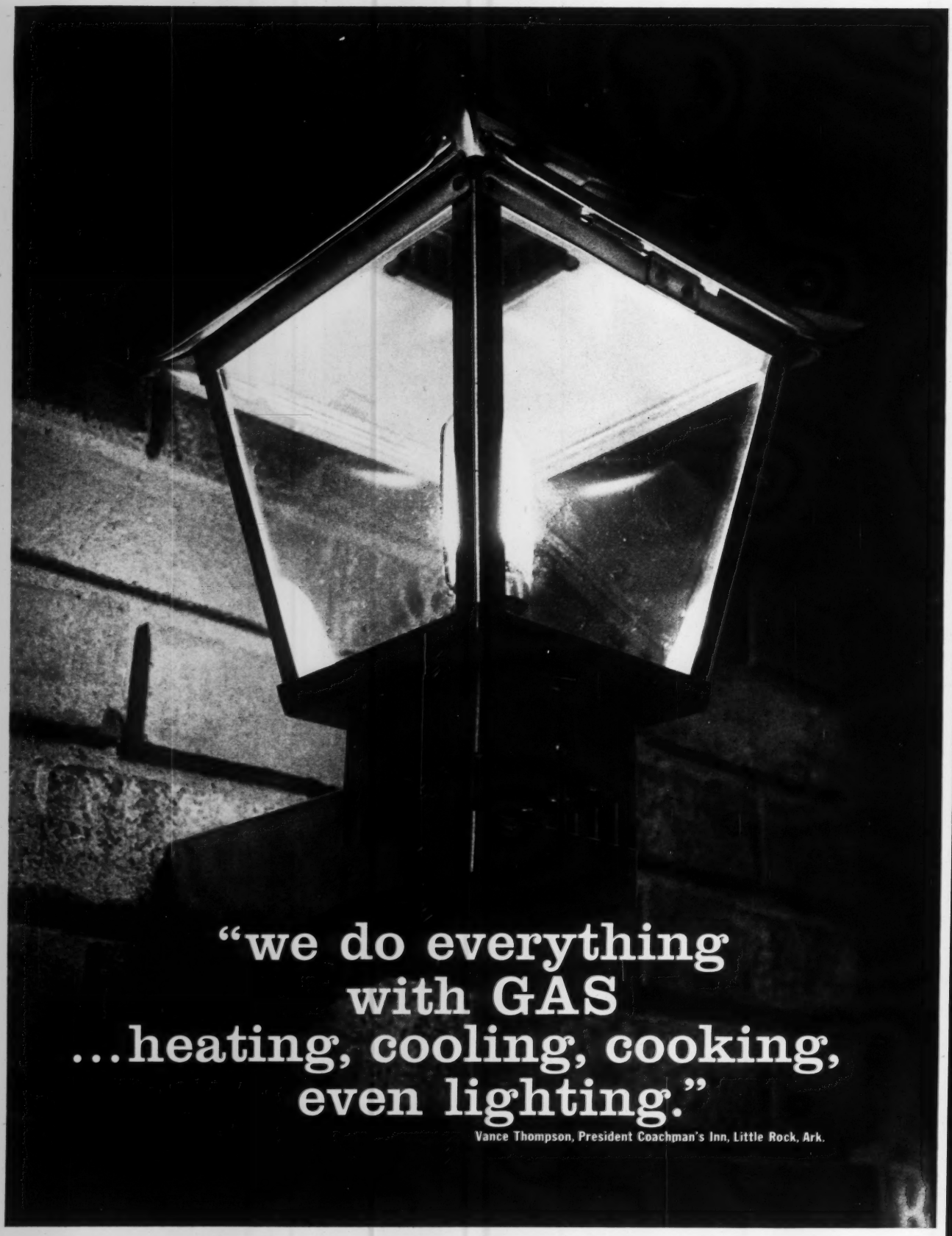
AMERICAN-STANDARD REMOTAIRE FAN-COIL CONTROL PACKAGES

OPERATION	DESIGNATION	WATER-FLOW CONTROL	AIR-FLOW CONTROL	THERMOSTAT
BASIC	C-100★	NONE	MANUAL FAN SWITCH (3-SPEED & OFF)	NONE
MANUAL	C-201★ C-301 C-131	2 SHUT-OFF VALVES THROTTLING VALVE; 2 SHUT-OFF VALVES 3-WAY MODULATING VALVE; 2 SHUT-OFF VALVES	MANUAL FAN SWITCH (3-SPEED & OFF); CONSTANT FAN OPERATION AT SPEED SELECTED	NONE
ELECTRIC	E-201★	NONE	THERMOSTATIC ON/OFF CONTROL OF FAN AT SPEED SELECTED; AUTOMATIC CHANGEOVER OF THERMOSTAT	WALL-MOUNTED
	D-301★ D-701★	THERMOSTATIC ON/OFF CONTROL OF 2-WAY OR 3-WAY SOLENOID VALVE; AUTOMATIC CHANGE-OVER OF THERMOSTAT	MANUAL FAN SWITCH (3-SPEED & OFF); CONSTANT FAN OPERATION AT SPEED SELECTED	WALL-MOUNTED
	F-301 F-701			UNIT-MOUNTED
PNEUMATIC	C-501★ C-701★ C-901★ C-111★	THERMOSTATIC MODULATING CONTROL OF 2-WAY OR 3-WAY PNEUMATIC VALVE (VALVE NOT FURNISHED, INCLUDES PARTS TO ACCOMMODATE VALVES OF TWO MANUFACTURERS.)	MANUAL FAN SWITCH (3-SPEED & OFF); CONSTANT FAN OPERATION AT SPEED SELECTED	WALL-MOUNTED
	C-601 C-801 C-101 C-121			UNIT-MOUNTED
SELF-POWERED	C-401	DETROIT VD216 "SELECTAFLOW" MODULATING VALVE WITH 3-VALVE FLUSHING BYPASS CLUSTER, AUTOMATIC CHANGEOVER	MANUAL FAN SWITCH (3-SPEED & OFF); CONSTANT FAN OPERATION AT SPEED SELECTED	UNIT-MOUNTED

NOTES: 1. ALL PACKAGES ARE AVAILABLE FOR TYPE 20 REMOTAIRE; THOSE DESIGNATED WITH ★ AVAILABLE FOR TYPE 30. 2. ELECTRIC-CONTROL PACKAGES ARE EQUIPPED WITH **AUTOMATIC** CHANGEOVER CONTROL AS STANDARD COMPONENT. 3. ELECTRIC-CONTROL WALL-MOUNTED THERMOSTATS ARE SINGLE POLE/DOUBLE THROW; FURNISHED SEPARATE FROM PACKAGE. 4. PNEUMATIC CONTROL VALVES AND THERMOSTATS ARE NOT FURNISHED. 5. PACKAGES ARE FACTORY-INSTALLED OR (WITH SOME EXCEPTIONS) AVAILABLE IN KITS FOR FIELD ASSEMBLY.

American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation

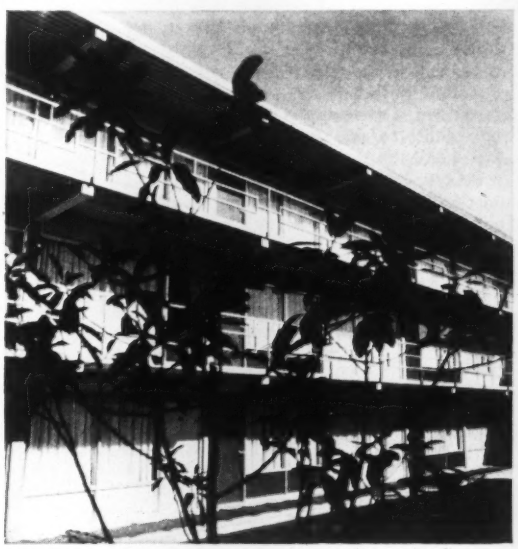
American-Standard
PLUMBING AND HEATING DIVISION


"we do everything
with GAS
...heating, cooling, cooking,
even lighting."
Vance Thompson, President Coachman's Inn, Little Rock, Ark.

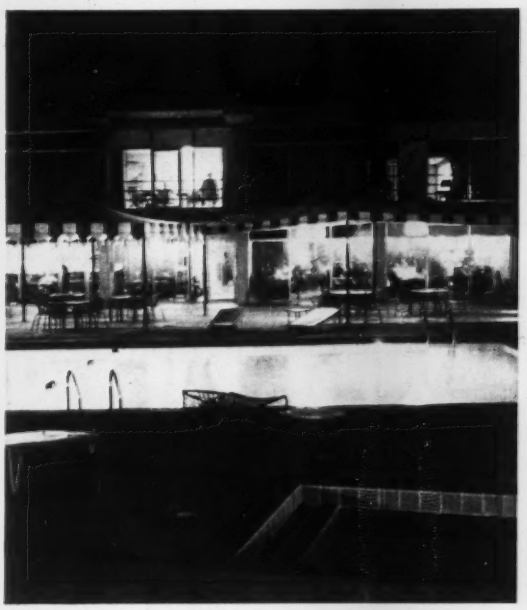
The new Coachman's Inn . . . a 258-unit motel in downtown Little Rock . . . is the last word in ultramodern convenience and comfort. In the words of satisfied guests, it has everything.

And everything there that depends on fuel depends on GAS, the most flexible modern fuel. Even the electricity used at the Inn is produced by a gas-driven generator!

Six 25-ton Arkla-Servel Gas absorption units provide summer air conditioning. The source of energy for the chiller units is low pressure steam from a gas-fired boiler. The same boiler furnishes heat in winter.



Guests and management alike appreciate the automatic convenience of the Arkla-Servel gas absorption cooling system. The chillers shut themselves down, one by one, as the load decreases. And, since cooling requirements seldom exceed 80% of capacity, one unit can be shut down if necessary without affecting cooling efficiency.



At the Coachman's Inn, year 'round air conditioning is only part of the job for gas. Gas cooks the meals. Heats all water, including the pool. Illuminates the decorative Arkla Gaslites. And, in gas flambeaux, adds a dramatic touch to the beautiful Sunken Patio.

Before you layout your next job, check the all-round efficiency and economy of gas. Remember, gas absorption cooling can put your customers' heating plants on a year 'round paying basis.

For specific details on Arkla-Servel systems, call your local gas company, or write to the Arkla Air Conditioning Corporation, General Sales Office, 812 Main Street, Little Rock, Arkansas.

AMERICAN GAS ASSOCIATION

FOR HEATING, COOLING, COOKING
...GAS IS GOOD BUSINESS

Architect's rendering of Alfred Speer Village, Public Housing Project at Passaic, N. J. Sarcotherm Heating Control Systems are used in this as well as in the Authority's Vreeland Village. Kelly & Gruzen were architects and engineers for both projects.

"THIS HOUSING PROJECT'S SARCOTHERM VACUUM HEATING CONTROL SYSTEM HAS BEEN EXCELLENT IN ALL RESPECTS...

Behind this report of complete satisfaction from the Passaic, New Jersey, Housing Authority are the basic reasons why it pays to install a Sarcotherm Outdoor Controlled Weather-Compensating System. These systems not only provide the precise temperature control so critical in housing projects, but are easy to install and operate, and never waste fuel. Sarcotherm's advantages cost no more, and the inherently simple design of the system keeps maintenance costs to a minimum.

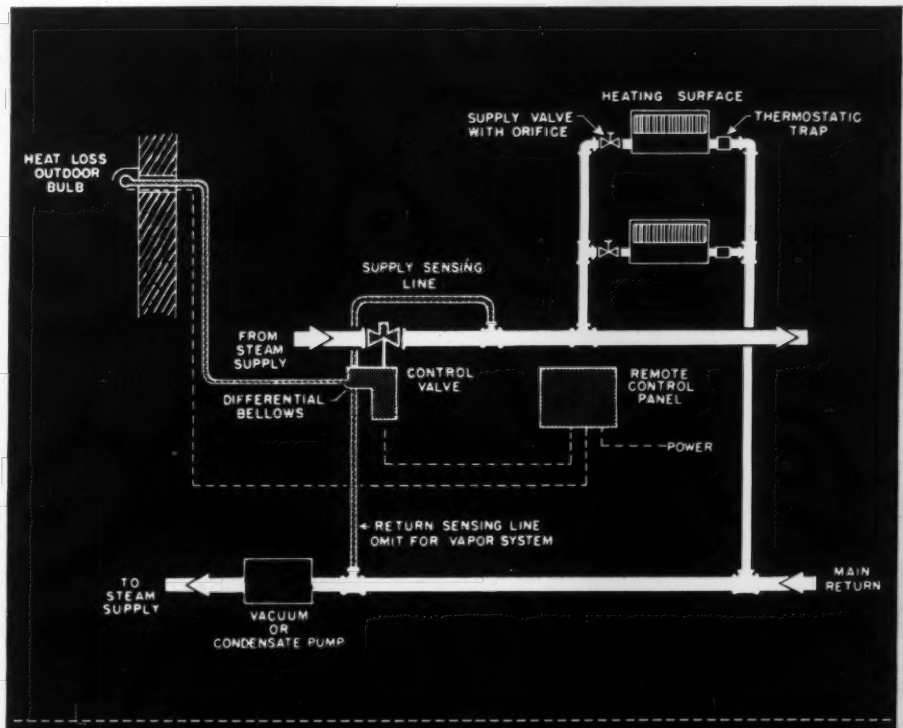
This project involved two installations, Alfred Speer Village, heated by steam, and Vreeland Village, heated by hot water. Both were directed by the Passaic Housing Authority and designed by Kelly and Gruzen Architects and Engineers. Sarcotherm engineers cooperated with their architects, engineers and contractors to achieve best results.

On projects like this, Sarcotherm saves time, effort and money. A minimum of wiring is required which makes for simpler, faster hook-ups. In operation, a Sarcotherm system cuts fuel costs through precise metering of delivered heat, yet an exact degree of comfort is provided regardless of outside temperatures. Operating personnel can easily make adjustments to maintain accurate specified temperature levels.

All Sarcotherm components are built to the highest standards in the industry for long-lived reliability. In addition, a Sarcotherm contract brings you the advantages of single-source responsibility: you get your complete control system as well as heating specialties and accessories from a single centralized supplier. Write for Sarcotherm Control Catalog. Specify steam or hot water.

SARCOTHERM

SARCOTHERM CONTROLS, INC.,
AN AFFILIATE OF SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.



Schematic hook-up of typical Sarcotherm Steam Heating Control System at Alfred Speer Village apartments, Passaic, N. J. Vreeland Village utilized Sarcotherm hot water controls.

Here are just a few of the many other

PUBLIC HOUSING PROJECTS using SARCOTHERM WEATHER-COMPENSATING HEATING CONTROL SYSTEMS

Name	Number of Zones	Installed
Marvine Village Bethlehem, Pa.	82	1952
Cherry Hills Baltimore, Md.	53	1956
Hanover Acres Allentown, Pa.	35	1939
Beardsley Terrace Bridgeport, Conn.	16	1953
Fayette County Housing Fayette Co., Pa.	15	1951
Rome Housing Rome, N. Y.	8	1952
Norwalk Project No. 1 Norwalk, Conn.	8	1950
Norwalk Project No. 2 Norwalk, Conn.	2	1952
Commodore Perry Buffalo, N. Y.	6	1956
Scranton Housing Scranton, Pa.	6	1953
Pequonnock Housing Bridgeport, Conn.	4	1954
Long Branch Housing Long Branch, N. J.	3	1958
Waterbury Housing Waterbury, Conn.	3	1953
Port Chester Project No. 1 Port Chester, N. Y.	2	1949
Port Chester Project No. 2 Port Chester, N. Y.	2	1951

...AND THERE'S BEEN MINIMUM MAINTENANCE," SAYS THE PROJECT ENGINEER... AFTER 7 YEARS OF TROUBLE-FREE OPERATION

Year-in, year-out heating comfort for these housing projects is only part of the story. Maintenance of the Sarcotherm Heating Control System is another, and the Passaic, New Jersey Housing Authority says that only a minimum of service has been required. Reason: Fewer parts and simplified wiring.

Sarcotherm plans for your heating system's future from the very beginning. For example, Sarcotherm always unit packs and tags every component, prepares complete working drawings, and keys all parts to the drawings. Trained Sarcotherm personnel contribute to the speed and efficiency of the work on the job, make final adjustments, and take the system through start up. Sarcotherm provides complete operating manuals and instructs the people who will operate the system. This not only reduces installation time, but sets the stage for trouble-free operation in years to come.

All projects like those described here can benefit from Sarcotherm's more than half century of specialized experience in steam and hot water systems. Get more information about Sarcotherm on-the-job cooperation, and how it contributes to the speed and efficiency of installation and initial adjustment. Write for your copy of the Complete Control System Catalog. Specify Steam or Hot Water.

FOR COMPLETE CONTROL SYSTEM CATALOG write Sarcotherm Controls, Inc., 635 Madison Avenue, New York 22, N. Y.

SARCOTHERM

SARCOTHERM CONTROLS, INC.,
AN AFFILIATE OF SARCO COMPANY, INC.,
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

DURIRON PIPE

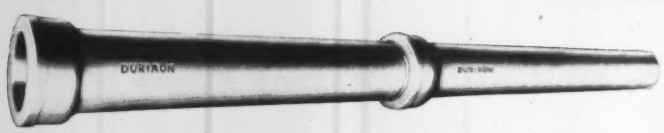
FOR CORROSIVE WASTE DISPOSAL

IT'S BETTER

BETTER FOR THE ENTIRE SYSTEM

BETTER IN THE APPROVED METHOD OF INSTALLATION

PROVEN FOR OVER 40 YEARS



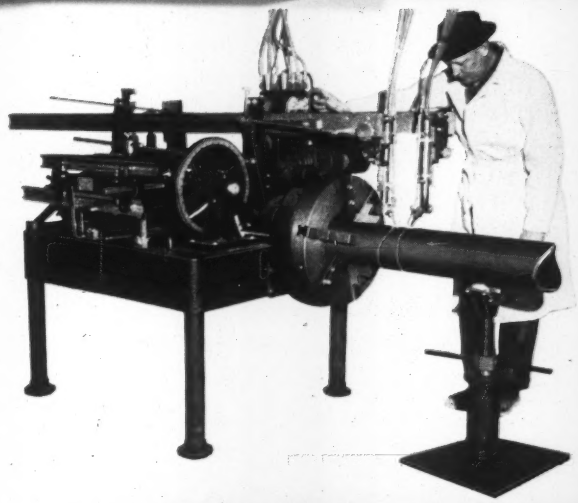
BETTER FOR THE ENTIRE SYSTEM... Put in the complete job in *Duriron*. Embed it in concrete . . . Bury it in the ground . . . Hide it above the false ceiling . . . *and forget it!*

BETTER INSTALLATION... By standard plumbing practice—identical to soil pipe. With a full line of fittings to meet any building code.

PROVEN FOR OVER 40 YEARS... In handling corrosive wastes you've got to be sure. *Duriron* is the only material with a record of performance for the life of a building.

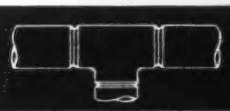
The complete acid-drainage system in *Duriron* will be *better* all around. Safety and assurance to the owner . . . complete ease of mind to the specifier . . . and facility in plumbing to the contractor.

THE DURIRON COMPANY, INC. DAYTON, OHIO DURIRON



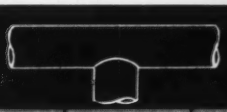
Here's PROOF that a Steffan Automatic Contour Cutter can save you up to 75% on pipe fabrication

The cost comparison below is based on actual case studies using known shop rates, pipe and tee costs. It's mathematical proof that a Steffan Automatic Contour Cutter, working in conjunction with a Steffan Automatic Hole Cutter, will save you as much as 75% in pipe fabrication in the elimination of forged components and welding time.



FORGING

Pipe Size	Forged Tee	Mill Cost Pipe	Labor	Total
4	$ 12.70	$ 12.24	$ 15.80	$ 40.74
8	44.04	16.37	29.90	90.31
12	113.08	28.58	52.80	194.46
24	434.84	42.26	103.60	580.70



SADDLE JOINT

Pipe Size	Mill Cost Pipe	Labor	Total	Saving
4	$ 13.77	$ 11.06	$ 24.83	39%
8	20.30	21.25	41.55	54%
12	40.95	35.40	76.35	61%
24	80.00	69.80	149.80	75%

Note: Figures are based on a $6.00 per hour shop rate. The cutting and beveling rate is the same for both pipe joining methods. Welding time is based on 1½ lineal inches per minute. 8" pipe and smaller, requires 2 welding passes and 10" to 24", 3 passes.

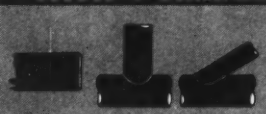
The tremendous savings shown in our cost comparison chart are made possible by the fact that the Steffan Automatic Contour Cutter makes *layout time, cams* and *templates* obsolete. You no longer need these outdated devices to produce clean, close tolerance cuts and bevels for perfect junction-matching. The Steffan Contour Cutter does it for you . . . *automatically.*

The *entire* operation is automatic. Required settings (only 4 in all) are made in *seconds.* 1. Set scale to I D of pipe being cut. 2. Set scale to OD of mating pipe. 3. Set dial for angle of intersection. 4. Set scale for offset center lines (if offset joint is desired.) Torch is then positioned for cutting. If required, *two* torches may be used to simultaneously cut *both* ends of pipe. Cutting torches are solenoid controlled to insure proper flame setting . . . just push a button and they ignite electrically. When equipped with Heliarc, the Steffan Automatic Contour Cutter will cut *aluminum, stainless, magnesium* and *other alloys.* It's a perfectly controlled, completely automatic *one-man* operation.

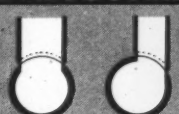
While the Automatic Contour Cutter is preparing the end of the branch pipe, the Steffan Automatic Hole Cutter is cutting the hole for the run pipe. When the two pieces come together a "tee" is formed and may be welded for a *perfect fit.* The Hole Cutter cuts perpendicular or angular holes in pipe or cylinders. It will also cut circles or elipses in flat plate. All are possible with just *three simple adjustments* on the Automatic Hole Cutter.

Here are two machines that no pipe fabricator can afford to be without. They are fast, easy to operate and require little maintenance. They are a real investment because *they pay for themselves* in savings from 35% to 75% in time and materials. It costs absolutely nothing to find out more about Steffan machines. One of our representatives will be happy to tell you all about them and arrange a *free demonstration.* Write today for literature.

WITH 4 SIMPLE DIAL ADJUSTMENTS . . . DO 6 DIFFERENT OPERATIONS:

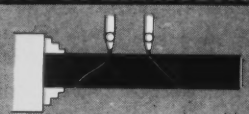


1. CUT STRAIGHT, SADDLE OR LATERALS . . . Do straight cut-offs. Do straight cut-offs with bevels. Do saddle cuts with bevels. Do laterals with or without bevels. Pipe may be size-on-size or unequal sizes. The Steffan Automatic Contour Cutter figures them all to tolerances never before possible.



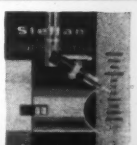
2. CUT CENTER OR OFF-CENTER CONTOURS . . . When an off-center joint is required, such as used for air lines when water drainage is a problem . . . the Steffan Automatic Contour Cutter mechanically calculates the proper contour for a perfect fit regardless of wall thickness or size differences.

3. CUT VARIABLE BEVELS . . . When laterals are cut, the Steffan Automatic Contour Cutter makes the necessary allowances to provide ideal welding conditions. As an example, a 45° lateral will have a 60% bevel at the crotch and a 15% bevel opposite.

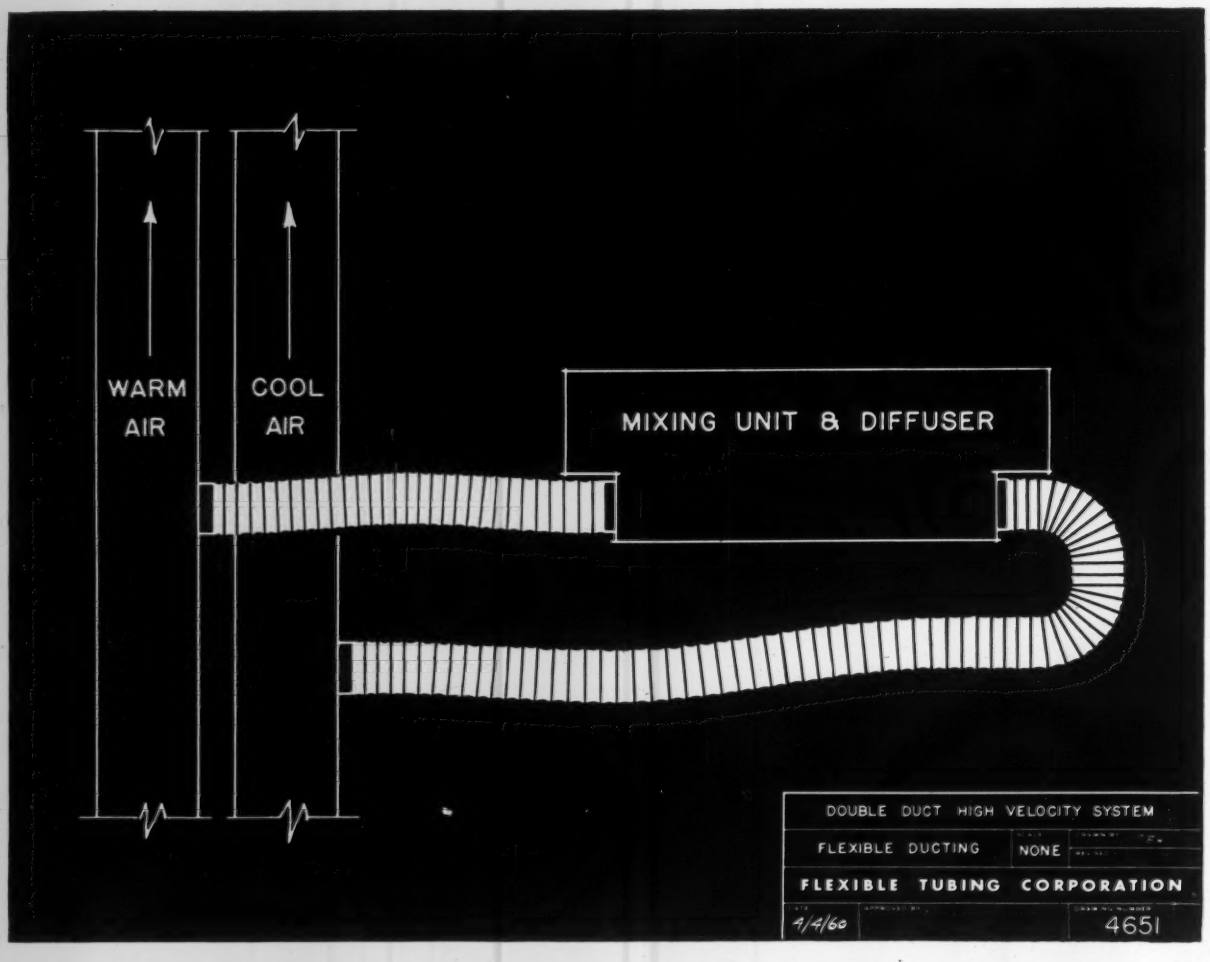


4. CUT DISSIMILAR ENDS SIMULTANEOUSLY . . . With the easy to install double-end attachment, Steffen Automatic Contour Cutter will cut and bevel both ends of a pipe at the same time. Production cutting can be planned for peak efficiency and material savings.

Write for brochure No. CC-5 for more information on the Steffan Automatic Contour Cutter and Accessory Machines.



Steffan Manufacturing Corporation
1585 S. Lincoln Avenue, Salem, Ohio



In the double-duct system . . .

Flexible Tubing simplifies connections to diffusers...gives you greater design flexibility

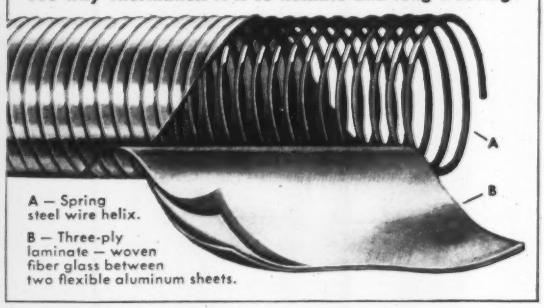
Flexible Tubing is designed to help you in laying out both low- and high-velocity air conditioning systems.

It's extreme flexibility allows taking ducts around obstructions and through tight passages, in gradual, gentle bends with minimum air flow loss. Even when sharp bends are necessary, duct cross-section is held constant by the tubing's strong supporting wire helix — there's no air restriction!

Flexible Tubing greatly reduces mechanical noises due to vibration . . . corrects for misalignments at points of take-off. What's more, it's lightweight, rugged, easy to install, long-lasting.

Capitalize on the flexibility of this remarkable product in the next system you design. The Contractor, the Installer will like it, too. For complete product data on Underwriters'-approved Thermaflex®, write to Flexible Tubing Corporation, 55 New Whitfield Street, Guilford, Conn.

See why Thermaflex-A is so flexible and long-wearing!



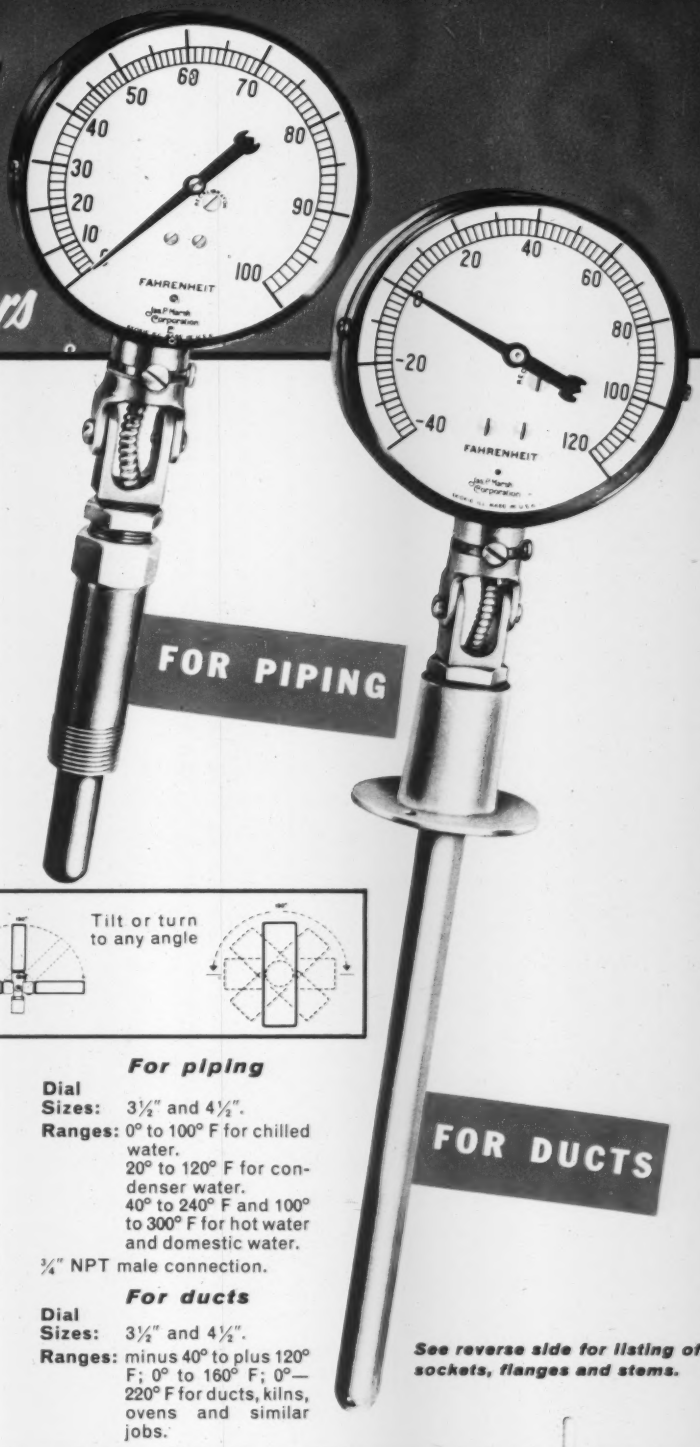
A — Spring steel wire helix.

B — Three-ply laminate — woven fiber glass between two flexible aluminum sheets.

Flexible Tubing
CORPORATION
Anaheim (Los Angeles) • Guilford, Connecticut
Hillside (Chicago)

NEW!

MARSH *Dial Thermometers*

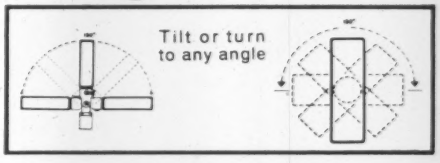


Designed expressly for piping and duct work

One careful look at this new line of Marsh instruments will convince you that we have put into them *everything* that has been so long and widely needed in dial thermometers for piping and duct work . . . thermometers for use on heating and cooling equipment—for piping, air ducts, vessels and kilns, ovens and similar installations.

THE LINE IS COMPLETE. Four types, 7 ranges . . . 72 combinations to meet almost every conceivable condition as listed on the reverse side of this page. All have basic features that are found only in the Marsh line:

FAR MORE READABLE. Big, legible 3½" and 4½" dials . . . easy to see in places where piping and duct thermometers must be located. An even greater contribution to ease of reading is the provision for tilting and turning dials to any required angle of vision as diagrammed here and on the following page. No more climbing ladders or using flashlights to read obscure glass tube thermometers. And note that the line includes distant reading types that bring the dial into view even if the point of measurement is completely out of range.



UNBREAKABLE. Instead of the fragile glass tube thermometers customarily used for piping and duct work you now have the sturdy, unbreakable Marsh Dial Thermometer . . . long recognized as the best; now still more highly perfected.

MORE ACCURATE. Guaranteed accurate to plus or minus one division of the big open scale, these instruments have far greater *readable* accuracy than any glass tube thermometer. They also have the famous Marsh "Recalibrator"—to *keep* them accurate.

MORE ADAPTABLE. Your needs "designed" these instruments! Notice in the specifications on the following page how their design provides for every field condition. Separable sockets ("wells"), along with swivel nut for attachment of thermometer to socket, makes them easy to install—or to disconnect for servicing. Extension necks take care of insulated piping or ducts. Long stems in duct types place temperature-sensitive section where it should be for accurate indication.

To know the full scope of this new Marsh line read the specifications on the reverse side of this page. Every instrument in the line is—

Available from stock

Write for Bulletin PD

For piping

Dial Sizes: 3½" and 4½".

Ranges: 0° to 100° F for chilled water.
20° to 120° F for condenser water.
40° to 240° F and 100° to 300° F for hot water and domestic water.

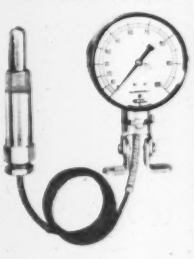
¾" NPT male connection.

For ducts

Dial Sizes: 3½" and 4½".

Ranges: minus 40° to plus 120° F; 0° to 160° F; 0°—220° F for ducts, kilns, ovens and similar jobs.

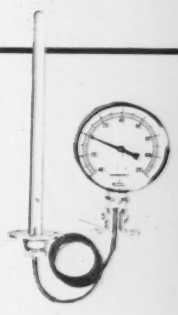
See reverse side for listing of sockets, flanges and stems.



Also remote reading

Piping and duct thermometers of same basic design are available with six feet of capillary tubing as shown.

See reverse side for listing of sockets, stems, ranges, etc.



. . . . Specifications on reverse side

specifications OF MARSH PIPING AND DUCT THERMOMETERS

(read complete description on preceding page)

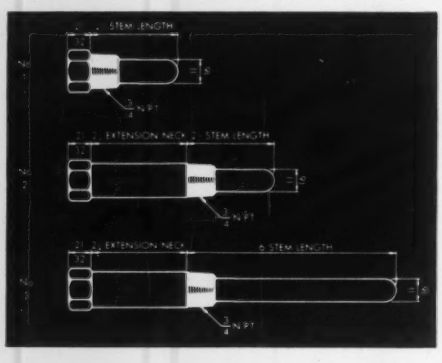
PIPING THERMOMETERS

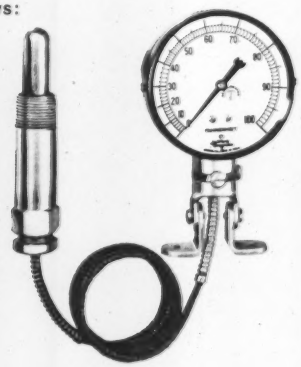
Piping thermometers are the Vapor Tension type which permits wide divisions in the important reading area (see cuts). They are standard with Marsh "Recalibrator." Both direct mounting and remote reading types, as illustrated here, are standard as follows:

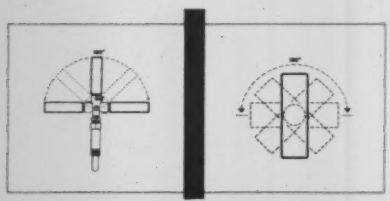
Two sizes:
3½" and 4½" dial size.

Four ranges:
0° to 100° F for chilled water.
20° to 120° F for condenser water.
40° to 240° F for hot water heating and domestic hot water.
100° to 300° F for hot water heating and domestic hot water.

Connection
¾" NPT male.

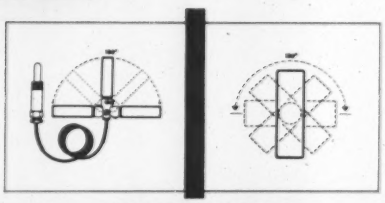






DIRECT MOUNTING

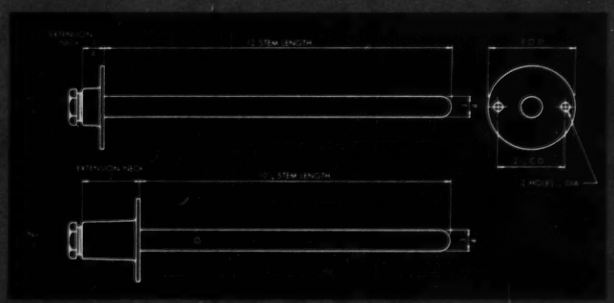
Three standard separable sockets for any thermometer in any range (see dimensions in drawing). Additional sockets may be purchased. Diagrams show how thermometers may be tilted and rotated.

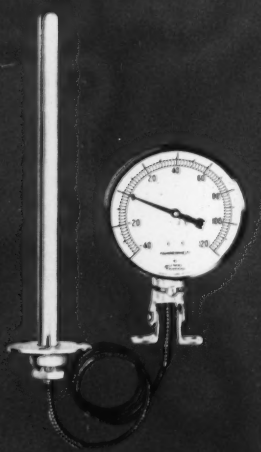


REMOTE READING

DUCT THERMOMETERS

Duct thermometers are the Gas Filled type, ideal for the wide ranges required. They are standard with Marsh "Recalibrator." Both direct mounting and remote reading types, as illustrated here, are standard as follows:

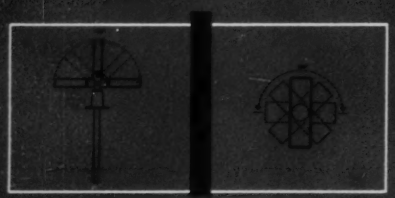




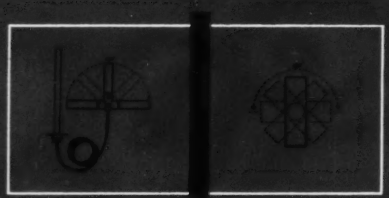
Two sizes:
3½" and 4½" dial size.

Three ranges:
minus 40° to plus 120° F
0° to 160° F
0° to 220° F

Two extension necks and stem lengths
for any thermometer in any range (see dimensions in drawing). Diagrams show how thermometers may be tilted and rotated.



DIRECT MOUNTING



REMOTE READING

MARSH

Marsh products include: *Pressure Gauges • Dial Thermometers* • Steam Traps, Radiator Valves and Traps, Vents and other heating specialties • Refrigeration Testing Instruments • Water Regulators • Solenoid Valves • Needle Throttling Valves.

Write for bulletins

MARSH INSTRUMENT COMPANY, Skokie, Illinois
Division of Colorado Oil and Gas Corporation

WHAT 7 THINGS HAPPENED RECENTLY AT FRICK COMPANY* IN WAYNESBORO, PENNA.

?

7 important things for FRICK *. . . and you:*

1. First of all, on a foundation of our 107 years' experience, our new management has established a growth policy that stresses new product development, quality control, and expansion of field services.

2. New branch offices are being opened and the sales-engineering staffs of existing branches as well as of the home office are being increased.

3. A compressor of new design is being developed. This, like our current dependable line, will handle a variety of refrigerants such as Freon, ammonia, propane, butane and carbon dioxide.

4. A new circulating system using refrigerated sea water has been introduced to commercial fishing fleets, at a saving to boat owners.

5. Completely insulated Shell-Ice makers have been "packaged" for convenient field installation.

6. Service to the growing poultry industry has been highlighted by our new counter-flow-continuous poultry chiller, which uses refrigerated water instead of ice.

7. As part of the growth policy, we are increasing the number of Frick distributors. Some of our distributors have been with us 50 years.

All of which indicates one thing: Frick is "on the move!" If you're passing through Waynesboro this summer, stop in and see for yourself; you'll be able to enjoy our remodeled and air conditioned offices.

FRICK COMPANY

Waynesboro, Penna.

*Pioneers in depend*ability* since 1853: air conditioning, refrigerating, ice making and quick freezing equipment, power farming machinery and portable sawmills.

QUIET

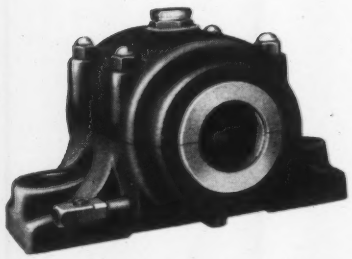
These quality bearings have been developed in close cooperation with manufacturers of fan and blower equipment — to meet the highly specialized requirements of this field.

The nation's great generating plants choose these bearings because of their extraordinary dependability—and the extreme quietness of their operation makes them top choice for air conditioning systems in hospitals, schools, theatres, auditoriums.

Dodge Fan and Blower Bearings are available from stock—with stock-product economy. Consult your local Dodge Distributor—or write us for technical data.

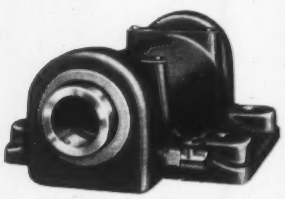
DODGE MANUFACTURING CORPORATION
1600 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.



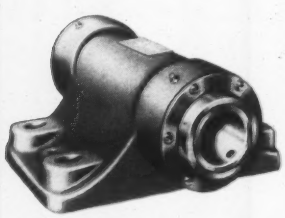
DODGE SLEEVOIL PILLOW BLOCKS

Exceptionally quiet in operation. Noted for superb quality. Plain and Water Cooled Types. Precision-built, ring-oiling, babbitted. Self-aligning. Can be drilled for thermostatic emergency warning. Shaft sizes from 1-7/16″ to 10″.



DODGE BRONZE BUSHED PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two bronze bushings of high lead content mounted in one cast iron housing. Special T-section rings for dependable lubrication. Exceptionally quiet in operation. Shaft sizes from 15/16″ to 2-3/16″.



DODGE BALL BEARING PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two precision single row, deep groove ball bearings in one cast iron housing. Extended inner race carries shaft. Remarkable ease of installation and maintenance. Shaft sizes from 15/16″ to 2-3/16″.

MANUFACTURER OF AMERICA'S MOST COMPLETE LINE OF MOUNTED BEARINGS

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DUAL-DUCT
through the
FOUR SEASONS

Let North winds blow, Summer sun glow —Buensod Dual-Duct affords complete conditioning through all the seasons of the year, heating and cooling, always maintaining proper conditions in every space. And this Buensod-pioneered "all-air" system, with patented automatic volume-controlled mixing units, provides constant air volume in every zone, regardless of variance in static pressures. That means the installation cannot be thrown out of balance, ever. Learn why Dual-Duct is the logical choice for new and renovated structures alike. Write for Bulletin DD-6 or contact your local Buensod representative and get complete details.

BUENSOD DUAL-DUCT

BUENSOD·STACEY

Buensod-Stacey Corp. 45 West 18 Street, New York 11, N. Y.

Subsidiary of Aeronca Manufacturing Corporation

Friends of

UCON IKE:

throw away your wrenches!*

NOW... EASY HANDWHEEL CYLINDER VALVES

... exclusive with Ucon brand refrigerants

First Time Ever! Here's a handy new idea in refrigerant cylinders: a handwheel valve you simply turn to open, turn to close. No wrenches, no stripped threads. And, no leakage problems, because these new Ucon Brand Refrigerant valves are made without packing. There's nothing to adjust or maintain! They're yours on Ucon Refrigerant cylinders—at no increase in cost. *Ask Your Wholesaler Now* about Ucon Refrigerants—first with conveniences for refrigerant users.

* Or *keep* them if you like—they make great paper weights!

A UNION CARBIDE product — Ucon BRAND refrigerants — exclusive sales agent ANSUL

Ucon Brand Refrigerants are manufactured by
UNION CARBIDE CHEMICALS COMPANY— Division of Union Carbide Corporation
30 East 42nd St., New York 17, N. Y.
Exclusive Sales Agent to Air Conditioning and Refrigeration Wholesalers
ANSUL CHEMICAL COMPANY, Marinette, Wisconsin

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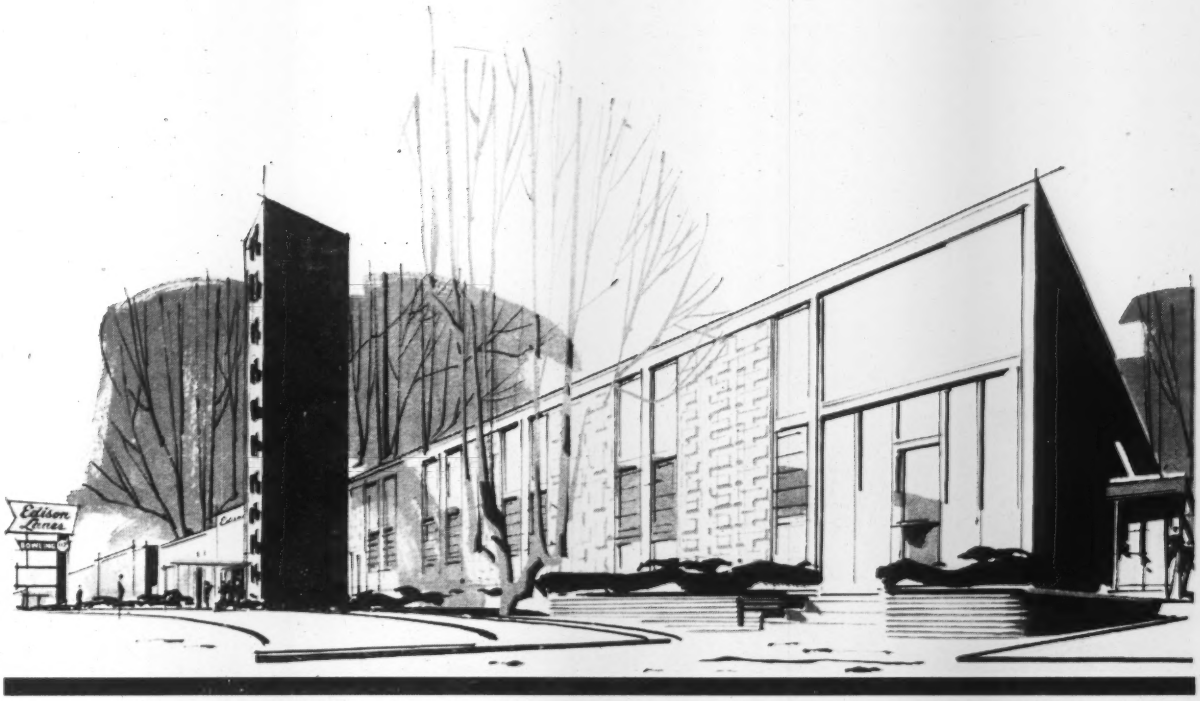
Climate by Chrysler



Edison Lanes, Edison Township, N. J. Chrysler Air Conditioning Contractor: Nicholas W. Schwalje, Inc., Metuchen, N. J.

World's largest bowling lanes cooled by Chrysler Packaged Air Conditioning

Almost a quarter of a mile separates Lane No. 1 from Lane No. 112 at Edison Lanes, Edison Township, N. J. If a bowler ever made the trek, then Chrysler Packaged Air Conditioning units would be keeping him cool and comfortable every step of the way.

It takes 340 tons of air conditioning to cool bowlers behind the foul lines and in the service areas. Since it is not necessary to cool the lanes themselves, the diffusers and air returns are concentrated at the foul lines to create a "curtain wall" effect. This prevents cool air from spilling out of the conditioned areas.

The 20- and 30-ton Chrysler Air Conditioners are self-contained evaporative condenser units with dual compressors. They're specially arranged to provide zone control, so only the lanes in use need be cooled.

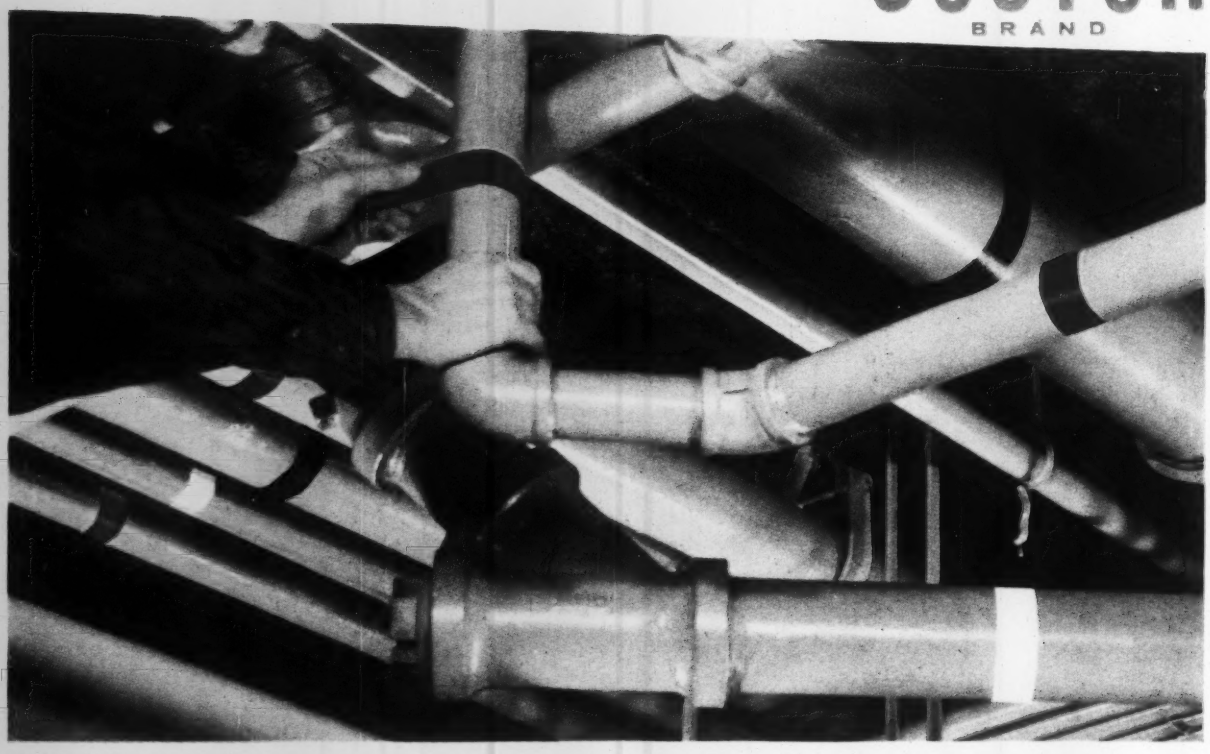
Chrysler equipment was selected for this job because it offered the owners the twin advantages of flexible installation and most economical operation. For more information, or the technical cooperation of a Chrysler air conditioning engineer, write today.

CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. Y-50, Dayton 1, Ohio

In Canada: Therm-O-Rite Products, Ltd., Toronto, Ontario

SCOTCH
BRAND



TAPEnology . . . industry's newest cost-cutting tool

TAPE COLOR-CODES PIPELINES FOR EASY TRACING OR SERVICING

See how easily colored "Scotch" Brand Plastic Tape provides at-a-glance identification for pipe and duct systems. Colored bands roll on dry—stick at a touch to any clean, dry surface. Tape is easy to apply even in cramped hard-to-reach areas.

Color coding with "Scotch" Plastic Tape simplifies tracing or servicing of fluid lines, electrical conduit, air ducts, and other in-plant systems. What's more, eight vivid colors—red, green, black, orange, yellow, blue, white, brown—and a variety of widths permit hundreds of code combinations. Won't chip, bake, or flake off. Resists acids, alkalies, greases, salts, and most solvents—lasts for years.

"Scotch" Plastic Tape is also excellent for lane marking and indicating storage zones or restricted areas on floors.

What's your marking problem? Chances are it can be solved with a "Scotch" Brand Tape. Ask your nearest "Scotch" Brand Tape Distributor or write: 3M Company, 900 Bush Avenue, St. Paul 6, Minn.

When tape costs so little, why take less than "SCOTCH" Brand?

"SCOTCH" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 6, MINN.
EXPORT: 99 PARK AVE., NEW YORK 16. CANADA: LONDON, ONTARIO.

Minnesota Mining and Manufacturing Company
. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

SCOTCH BRAND
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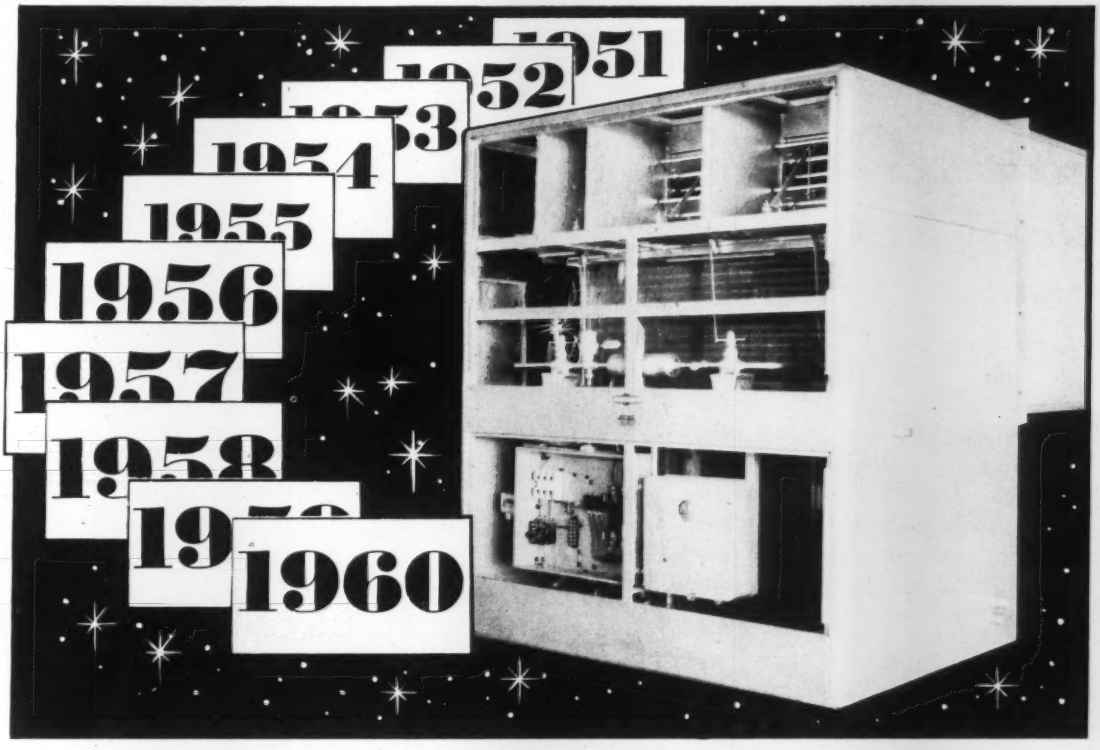
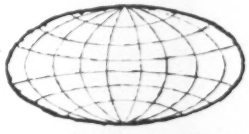


a decade of **proven** performance in self-contained multi-zone units



Yes, for ten years, GOVERNAIR has led the way in the engineering and development of self-contained multi-zone air conditioning units.

Both the Evaporative Condenser Package (type SCMZ) and the Water Cooled Condenser Package (type STMZ) are far beyond the pioneering stage, and have been tested and proven in actual use throughout the world, under widely-varied conditions.

Available in 8 through 100 tons, every unit is "Satisfabricated" to fit individual job zone and capacity requirements . . . assembled from the finest materials and components, then thoroughly factory-tested before delivery. For complete information, please write . .

GOVERNAIR

4840 NORTH SEWELL • OKLAHOMA CITY, OKLA.

THERE IS A DIFFERENCE IN PIPE FITTINGS

Speedline®

CONTROLS WALL THICKNESS AT THE BEND

Long tangent elbows may *look* very much alike—but micrometers don't deceive. "Section" a Speedline elbow and compare it with any other. Then consider the difference Speedline *controlled wall thickness* can make in your critical process lines.

Controlled wall thickness means you get consistent fitting strength and effective corrosion resistanee *all along the line.* Speedline forming equipment assures accurate control of wall thickness . . . at the bend in accordance with MSS-SP-43 specification. And you can count on Speedline quality control whether you specify Speedline fittings in stainless steel, aluminum, titanium, Hastelloy or other special corrosion-resistant alloys . . . including eccentric reducers and reducing tees and crosses.

Leading plants have proved there *is* a measurable difference in quality with Speedline fittings . . . the only complete line of long tangent fittings available from distributor stocks from coast to coast. Let a Speedline distributor prove the difference Speedline can make at your plant.

See pages 1513 to 1516 of the Chemical Engineering Catalog for Distributor listing. Complete catalog information available on request.

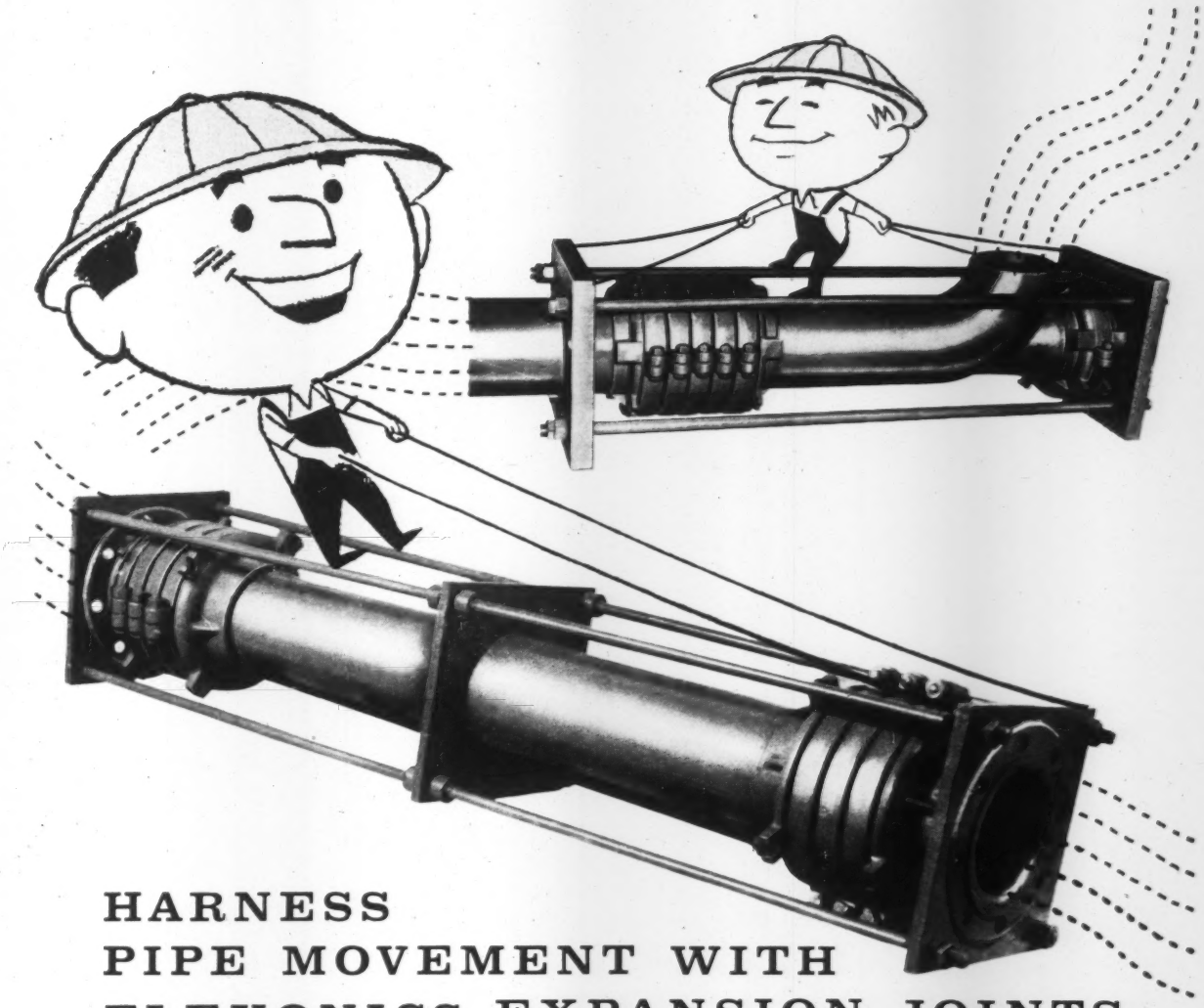
Out-Dated Forming Methods Reduce Wall Thickness as Much as 35% at the Bend.
Speedline's Controlled Wall Thickness is Measurable.

1004

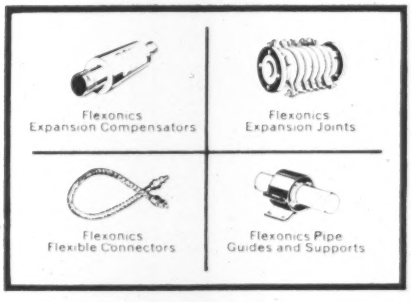
Speedline®

CORROSION-RESISTANT FITTINGS

A PRODUCT OF HORACE T. POTTS COMPANY • 576 E. ERIE AVENUE, PHILADELPHIA 34, PA.



HARNESS PIPE MOVEMENT WITH FLEXONICS EXPANSION JOINTS



Here's how to keep pipe movement under control! **Flexonics Self-Restrained Dual Expansion Joints** can absorb large amounts of lateral movement while keeping anchor forces at a minimum. **Flexonics Pressure Balanced Expansion Joints** replace main anchoring at changes in piping direction, by restraining the end thrust.

These are just two of the standard and special types of expansion joints engineered and built by Flexonics to help you harness pipe movement. **Check and mail the coupon today for complete information.**

EJMA Member Expansion Joint Manufacturers Association

EJ-260

Flexonics corporation

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ont.

EXPANSION JOINTS · METAL HOSE · SYNTHETIC HOSE · BELLOWS · AERO/SPACE COMPONENTS

SUBSIDIARY OF CALUMET & HECLA, INC.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

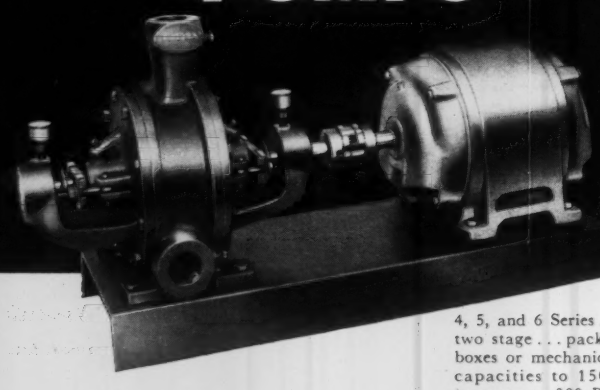
Flexonics Corporation
1391 South Third Avenue
Maywood, Illinois

Please rush me complete information on

- ☐ Expansion Joints
- ☐ Expansion Compensators
- ☐ Flexible Connectors
- ☐ Pipe Guides and Supports

MAXIMUM EFFICIENCY • LONGER SERVICE LIFE
• EASIER MAINTENANCE WITH

AURORA® APCO TURBINE TYPE PUMPS



4, 5, and 6 Series . . . single or two stage . . . packed stuffing boxes or mechanical seals . . . capacities to 150 GPM . . . pressures to 300 PSI. Ask for Bulletin No. S-111.

★ Long service life . . . with no metal-to-metal contact within the pump channel, wear is minimized.

★ *Easy Maintenance* . . . removal of end covers permits complete disassembly without breaking or disturbing the suction or discharge connections or motor-pump alignment.

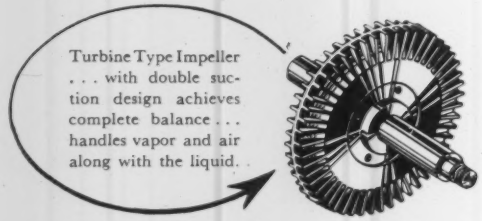
★ Complete hydraulic balance . . . achieved with double suction design . . . all hydraulic thrust on outboard bearings is eliminated.

★ Will not vapor bind . . . turbine type impellers handle vapor and air along with the liquid to eliminate vapor lock within the pump.

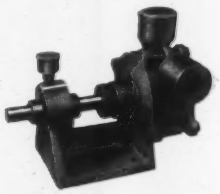
★ Wide operating range . . . constant capacity is maintained over wide head variations or fluctuating conditions—adjust quickly to changed operating conditions.

★ Ideal for low capacity, high pressure applications . . . boiler feed, condensate return, circulation services, booster services, LPG service, liquid transfer, water treatment, and filter services.

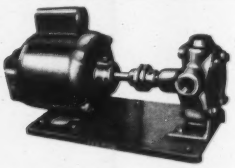
WRITE TODAY FOR FREE DESCRIPTIVE LITERATURE!



Turbine Type Impeller . . . with double suction design achieves complete balance . . . handles vapor and air along with the liquid.

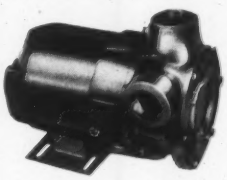


3 Series . . . Single stage . . . packed stuffing box . . . flexible coupling drive . . . capacities to 12 GPM, heads to 50 feet. Ask for Bulletin U-111-A.

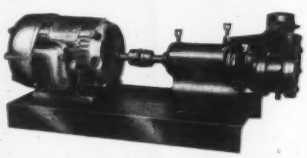


32 Series . . . single stage flexible coupling drive . . . mechanical seal . . . lubricated-for-life bearings . . . capacities to 10 GPM, heads to 250 feet. Ask for Bulletin U-111-B.

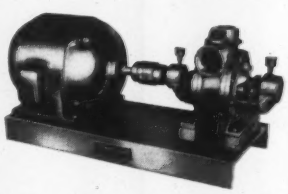
Type V31 . . . single stage close coupled . . . mechanical seal . . . self priming . . . capacities to 15 GPM, heads to 350 feet. Ask for Bulletin V-111-A.



Type V4 . . . close coupled . . . single stage . . . mechanical seal . . . capacities to 30 GPM . . . heads to 350 feet. Ask for Bulletin V-111-B.



Type Z4 Chemical Process . . . single stage or two stage . . . mechanical seal . . . capacities to 50 GPM . . . pressures to 400 PSI. Ask for Bulletin Z-111-A.



Type X40 . . . water jacketed packed stuffing boxes or mechanical seals . . . single or two stage . . . capacities to 60 GPM . . . heads to 350 feet. Ask for Bulletin 111XJ.

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY ®
650 LOUCKS • AURORA, ILLINOIS
LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

The family has grown!

...in size...in importance

The addition of a new and finer McDonnell 2-inch valve rounds out a line of safety relief valves for hot water space heating boilers that fulfills a vital need supremely well.

To know how true this is go back over the modern history of relief valves. With the rapid increase in closed systems, casualty companies, the National Board, and others concerned with boiler and heater safety went to work . . . and the net result was today's commendable A.S.M.E. Boiler Code calling for certified Btu-rated relief valves.

Closely following this work, McDonnell & Miller developed the first of all Btu-rated relief valves. They were not only first into the field; they are still first. They not only conform to the letter of the code; they go beyond this: *introduce new standards of their own.*

For Hot Water Space Heating Boilers

McDonnell Valve No.	Boiler Size Btu./hr.	Opening Pressure	Inlet	Outlet
230-¾ IN.-30	303,000	30 lbs.	¾″	¾″
240-¾ IN.-30	513,000	30 lbs.	¾″	1″
230-1 IN.-30	743,400	30 lbs.	1″	1″
240-1 IN.-30	910,000	30 lbs.	1″	1¼″
230-1½ IN.-30	1,025,100	30 lbs.	1½″	1½″
240-1½ IN.-30	1,560,000	30 lbs.	1½″	2″
240M-3	2,313,000	30 lbs. 36 lbs.	2″	1″ 2″
240M-4	2,710,000	30 lbs. 36 lbs.	2″	1¼″ 2″
240-2 IN.-30*	3,130,000	30 lbs.	2″	2½″
240-2 IN.-36*	3,550,000	36 lbs.	2″	2½″

*Recommended installation: 36 lb. opening valve, with smaller auxiliary valve set at 30 lbs. for thermal expansion.

New Bulletin P-33 gives up-to-the-minute facts

- A new bulletin shows why and how the entire rated capacity of McDonnell Relief Valves is obtained without diaphragms or other auxiliary lifting devices.
- It shows how this operation—this operation so basic to safety—is ideally accomplished by using specially calibrated "low rate" springs, matched to disc area to give smooth precise lift and tight closure.
- It explains the widely adopted McDonnell principle of progressive settings that keeps discharge in step with function . . . small valve relieving normal expansion; large stand-by valve ready for the emergency.

These and many more significant facts are covered in the bulletin. Note the accompanying table listing a valve for practically every boiler—McDonnell quality straight across the board.

Coupon brings your copy

McDONNELL & MILLER, Inc.
3500 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well

Your Jobber Stocks Them

McDONNELL

Safety Relief Valves

Boiler Water Feeders • Low Water Fuel Cut-offs • Pump Controllers • Flow Switches • Related Liquid Level Controls for Tanks, Stills, Air Conditioning Systems

Send me a copy of new Bulletin P-33 covering McDonnell Safety Relief Valves for hot water space heating boilers.

COMPANY NAME _____

STREET ADDRESS _____

CITY, ZONE & STATE _____

BY _____

Mail to: McDonnell & Miller Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

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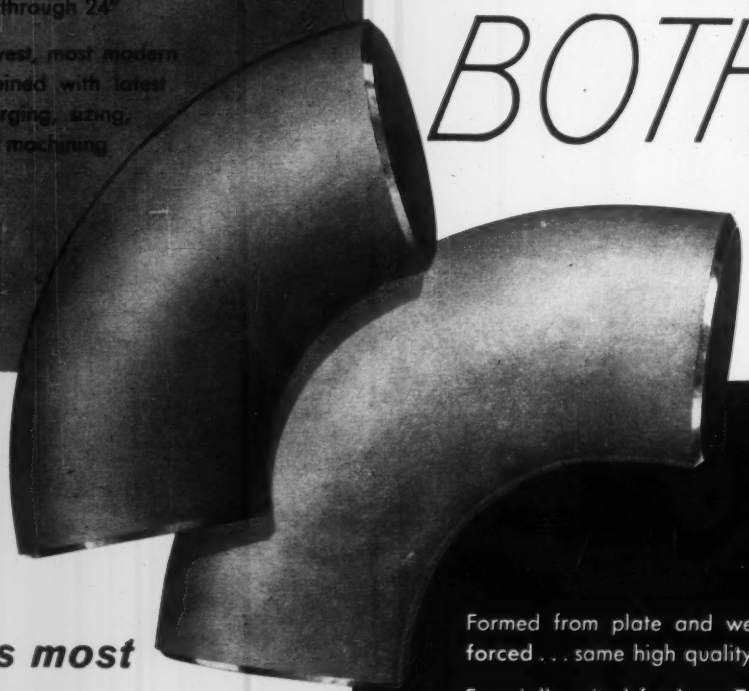

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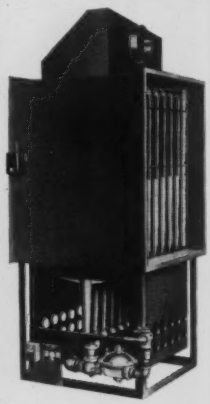
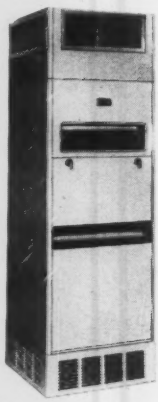
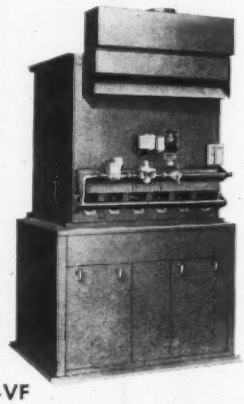


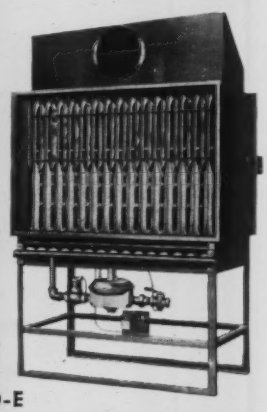
SED-S
Duct Furnace, 45,000 to 675,000 BTU Imput—End Surface



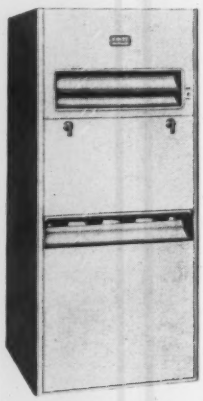
SEU-V
Vertical Unit Heater, 70,000 to 245,000 BTU Imput



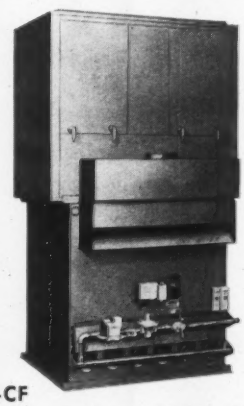
SED-VF
UP Vertical Duct Furnace, 70,00 to 280,000 BTU



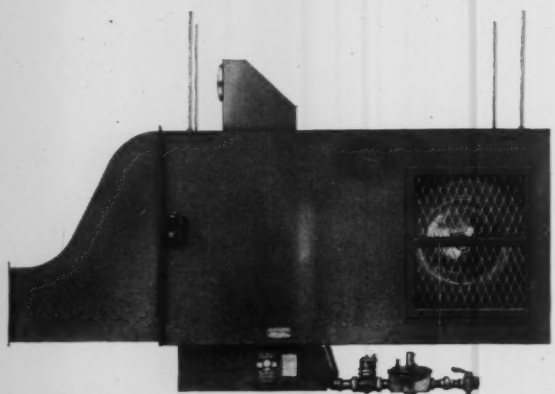
SED-E
Duct Furnace, 45,000 to 675,000 BTU Imput—Side Surface



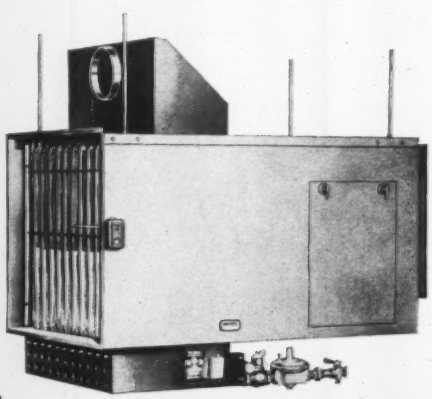
SEC
Forced Air Furnace, 70,000 to 245,000 BTU Imput



SED-CF
Counter Flow Duct Furnace, 70,000 to 280,000 BTU Imput



SEU
Suspended Unit Heater, 80,000 to 480,000 BTU Imput



SES
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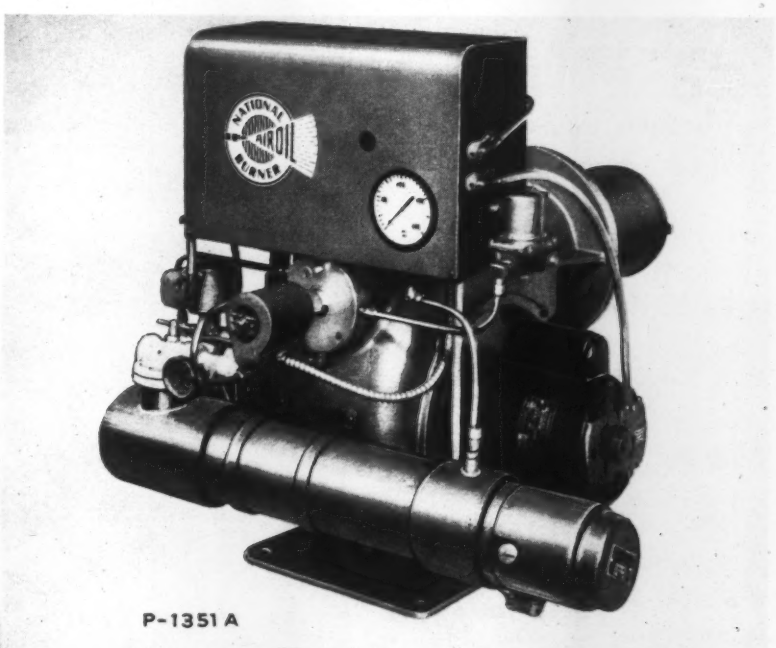
Bulletin 100 T contains complete data on the Type C-45 Oil Burner in its several natural or induced draft models and pressurized model. Write for a copy today.



P-1351 A

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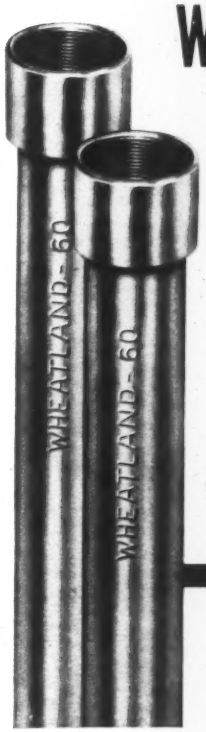

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"open for discussion"

We follow here each month the practice at engineering society meetings of providing an "open for discussion" period. You are urged to take part. Just address your comments to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

Dept. of the Army Spec Governs Design of USAF Heating Facilities

WILLIAM B. KOERNER'S reply to Willie Hammer ("Open for discussion," March) may give the impression that concrete duct construction for underground heat distribution is in general use on Air Force Bases within the United States. Actually, Air Force construction requires the use of galvanized, air testable, steel conduits in soils other than those determined by investigation to be dry; i.e., at no time will saturated ground exist above the bottom of any part of the conduit structure, in which event, vitrified clay tile and concrete trench may also be specified.

The Department of the Army, Office of the Chief of Engineers, which acts as a construction agency for the Air Force, has published "Specifications for Heat Distribution System, 24 March 1958" which is currently used for new construction. Headquarters USAF has, in addition, made use of this specification a requirement for all replacement or repair.

The Building Research Advisory Board, Div. of Engineering and Industrial Research, National Academy of Sciences, National Research Council has made a study of underground heat distribution systems and has published the results in FCC Technical Report Number 30R. This publication should be of great interest to those concerned with underground heat distribution problems.

ROBERT J. RUSCHELL
District Manager
Ric-wil, Inc.

Several Shipboard Air Conditioning Design Considerations Are Debatable

I HAVE READ *Shipboard Air Conditioning Design is Based on Unusual Considerations*, by Lewis Smith (October 1959), and consider it an excellent article. I would, however, like to make a few comments:

Despite the popularity growth of the dual-duct system, the terminal reheat system is still by far the more popular. This system is sometimes referred to in specifications as the "Class D" system. Recent practice includes higher temperature differentials (30 F maximum, compared with 20 F on most ships now afloat). Also, higher duct velocities and compensating sound attenuations are being used today to bring this class system "up to date." The author's remark regarding uneconomical operation is open to question. Steam is relatively cheap, and, obviously, low fan horsepower and temperature differential contribute to low operating cost.

High velocity is not a panacea for shipboard air conditioning. The economic balance between velocity, power, and noise requirements still must be considered in a good engineering design.

Regarding the author's remarks concerning inside staterooms, it is not uncommon today to have two-thirds of the staterooms inboard on air conditioned ships. These require cooling throughout the year. Air distribution in staterooms is the single greatest problem. Ceiling heights seldom are over 7 ft, 6 in., and may be as low as 6 ft, 8 in. Air changes in many cases are less than once every five minutes.

The practice of depending on reheating of air to prevent condensation on uninsulated ducts can be considered dangerous in view of a recent experience, when, through ignorance, several systems were operated without steam on the reheaters. It is also reasonable to reconsider all of the fundamental reasons for using insulation.

Regarding the conduit air conditioning system, it is of interest to note that on one ship the relatively high winter design temperature, 35 F, permitted omission of changeover. Thus, the system is operated on the "summer" cycle all year 'round, and hot

water systems are not required.

It is just as important that the outside load be kept to a minimum on a ship as it is ashore. The cooling load must be very light before 100 percent outside air can be used without excessive horsepower penalty. It should be noted that exhaust requirements usually set the minimum outside air quantities of systems serving staterooms.

JOHN W. MARKERT
Supervisor, Heating, Ventilating & Air Conditioning
Gibbs & Cox, Inc.
Naval Architects & Marine Engineers

One Important Phase of Balancing Air Exhaust Is Often Overlooked

THE ARTICLE, *Air-Starved Plants Can Breathe Easy Through Proper Makeup Ventilation*, by B. R. Small (October 1959), is extremely interesting and informative and covers its subject extremely well.

I would like to point out one phase of balancing air exhaust with air supply that is often overlooked. In large industrial buildings, quite often there will be a multiple number of exhaust systems. If there is not adequate air supply to balance the air exhaust, which frequently happens in wintertime when all the doors are closed, the stronger exhaust system may overcome the pull of the weaker exhaust systems and actually draw air into the building through some of the so-called exhaust systems and, thereby, introduce toxic vapors or fumes into the working space.

Furthermore, it may so reduce the exhaust from drying ovens which are drying paints or lacquers containing explosive solvents that the air inside the ovens may easily build up into the explosive range.

I have also known cases where adequate relief openings were not provided in buildings, particularly of the windowless type, and when the ventilation system supplied all outside air in the summertime there was no way for the air to get out. Excessive temperatures resulted. In one case I know of, it actually blew part of the roof off the building.

J. J. BURKE
Central Engineering Dept.
American Viscose Corp.

THE AUTHOR'S REPLY—Mr. Burke reports cases in air-starved plants where stronger exhaust systems overpower weaker ones and draw fumes and gases out of exhaust hoods into the building. Many such cases do exist and real harm is possible.

Both he and John H. Clarke place a deservedly high value on air supply facilities and troublefree dependable operation.

An opposite situation occurs in the increasingly popular solid curtain wall type of building where mechanically supplied ventilation air must have provision to escape, as Mr. Burke also points out.

These air escape openings must be adequately sized. A selection of permissible pressure within the building is necessary. A room pressure of 0.09 in. water gage is good practice and produces 1200 fpm velocity, while 0.15 in. WG gives 1500 fpm which is an extreme maximum. One recalls that 0.2 in. WG interferes seriously with operation of a 3 ft × 7 ft door, while about 5 lb per sq ft of force is produced by 1.0 in. WG.

If louvers or enclosures reduce the effective area of a given opening or openings, the openings must be increased correspondingly.

Roof mounted vents for air escape are preferred to back draft dampers in walls, because they are not throttled by adverse wind forces. Winter closing requires manual or motorized vent dampers. So-called air mover or thermovent types of vents have attractively low silhouette outlines, have built-in dampers, and are easily installed.

B. R. SMALL
Staff Ventilation Engineer
Aluminum Co. of America

Writer Finds Basic Shortcoming In Apartment's Heating, Cooling

I HAVE READ the article, *Fan-Coil Units' Flexibility Is Key to Heating, Cooling Plush Apartment*, by George Innes (December 1959), and would like to comment on the design discussed therein. As pointed out by Mr. Innes, the use of fan-coil units for apartments can undoubtedly result in a first-class installation, giving full comfort to the occupants at varying conditions of internal and external load.

There is however, in my opinion, one basic shortcoming in the design employed in this instance. The necessary ventilation air is introduced through a corridor supply system. Consequently, the supply air has no cooling effect by the time it enters the apartments proper — or the corridors would have to be subcooled. While the water distribution systems serving the fan-coil units are zoned, they can only provide cooling when they handle cold water or heating when they handle hot water, the amount of heating or cooling being controlled by local control valves.

It has been our experience that on many days of the intermediate seasons moderate cooling is required some areas, while moderate heating is required in other areas of the same zone. This may be due to partial outside shading of a building facade due to variation in internal loads or due to the desire by the various occupants for different levels of temperature.

Had the ventilation air been supplied through a duct running in the corridor ceiling and handling cool air, rather than by the use of the corridor as a supply plenum, these intermediate season conditions could undoubtedly have been met much more satisfactorily. At the same time, the lack of privacy

caused by the louvers between apartments and corridors could have been avoided.

The maintaining of a slightly positive pressure in the building rather than a slightly negative one is another feature I would recommend. (The present design is based on 8000 cfm exhaust and 6000 cfm supply per floor).

The design of the air conditioning system for the office building seems to forego all possibilities of zoning, due to the use of one water coil for both hot and cold water. In my opinion, provision for supplying air at different temperatures to the several exterior as well as interior zones of an office building are absolutely essential, even if individual room control is not contemplated.

JOHN J. MANN
Jaros, Baum & Bolles
Consulting Engineers

THE AUTHOR'S REPLY—It is always stimulating to have a fellow engineer comment on a working installation. Such criticism is welcome and worthwhile since it raises pertinent questions of value for consideration in the light of experience on other installations.

In operations of this character, both the architect and the engineer are under considerable pressure to produce a practical, workable building without pricing the owners out of the rental market.

Choice of design often involves a certain amount of philosophy aside from the purely theoretical aspects, in keeping with the owner's budget requirements and the physical limitations of the structure.

Admittedly, an outdoor air supply duct system, delivering a stated amount of either cooled or heated air to each individual apartment, would be a refinement on the present use of the corridor as a supply plenum.

Each corridor in each floor is 400 ft long. When you multiply this by 12 floors, with the attending ductwork, insulation, grilles, dampers, controls, installation, and a hung ceiling, the costs can be considerable. The economics do not warrant additional expenditures.

Actual operation of the present system, using the corridors to deliver controlled outdoor air to the apartments, works very well. Both the owners and the tenants are very happy with the situation. The building is occupied and has gone through two cooling seasons and two heating seasons without any complaints or problems arising from the corridor supply. The chilled air delivered to the corridors does have a cooling effect and to say that it has no cooling effect belies the actual operation.

Experience indicates that there is no lack of privacy. No tenant has complained that his privacy was in any way invaded, nor that any problems have been created by having the outdoor air introduced into each apartment through a louvered opening from the corridor.

Keeping the apartments under a negative pressure, instead of positive, as suggested, has advantages. The distinct possibility of permeating cooking odors is eliminated. It is far better in our opinion to exhaust and get rid of odors instead of pushing them around an enclosed space under pressure. Tenants cannot be regulated in any practical way from opening or closing windows at any time to suit their own fancy. Therefore maintaining positive pressures becomes difficult.

During the intermediate seasons, the operation of a building of this complexity prohibits supplying Mrs. Jones with heat and Mrs. Smith with cooling when they are both in the same zone. This could be done with a very intricate and expensive dual system of piping, coils, and air delivery. However the owner's budget stands in the way. In theory, it is possible to design such a system. But I doubt that it could be sold, except to a very limited clientele.

With 16,000 sq ft of open, undivided space on each floor of the offices, just where does the interior zone begin and end, and how do you define the zones? At present, the delivered air temperatures are constant and the amount delivered to the now-divided spaces is in controlled quantities.

One point in the published article needs to be corrected: The caption under the photo of the cooling towers would lead the reader astray. The air from the towers is not sent to any place except to be exhausted to the atmosphere. There is no cooled air discharged from these towers; all of the air is warm and at virtual saturation.

GEORGE A. INNES
Innes Associates
Engineers and Consultants

Nickel Mine Recovery Heat Exchange System Has Interesting Design

J. G. RUTHERFORD'S article, *Heat Outdoor Air for Nickel Mine by Recovery Heat Exchange System* (May 1959), is certainly another interesting variant on the many possible applications of the heat reclamation principle.

The economic advantages of the heat exchange system described can be readily appreciated by anyone who has been faced with the problem of producing heat in northern areas where Btu's are hard to come by.

The illustrations associated with the article very effectively describe the devices used in the heat exchange process involved. However, one wishes that the author had included a sectional elevation view of the mine in order to aid the average reader, presumably unfamiliar with mining engineering, in getting at least a more immediate picture of the air dis-

tribution scheme and the fan arrangements at the various underground levels.

Now, regarding the certain design aspects of the heat exchange system in question, we have the following comments to offer:

The sketch and photograph accompanying the article show the air heating coils installed directly exposed to the atmosphere. Our first reaction is to inquire how it is expected to overcome the problem of blockage of the coil surfaces by snow entrained by the incoming supply air or by outside wind action.

It is realized, of course, that the coil heat will eventually melt this snow. However, it should be remembered that the heat which would thus be dissipated in the process of heating and melting of the snow, starting from a subzero outside temperature, represents so much heat unavailable to raise the temperature of the outside air through the required range.

Further, even if the additional heat required were no problem, whatever snow is melted will eventually turn to water, and this poses other problems. One is the entrainment of this water into the supply system. Another is the freezing of this water upon contact with subzero outside air. This, in turn, could lead to icing conditions along the unheated exterior edges of the coil frames, thereby causing thermal stresses in the coil structure owing to the large temperature differences between the coil surface and the outside air. Over and above these aspects, consideration should be given to probable unequal distribution of surface temperatures along the coil tube length. This would mean correspondingly uneven heating of the outside air as it passed through the coil.

If, as one might anticipate from the above comments, these difficulties should be experienced, the following suggestion might deserve consideration.

To protect the entire coil surface from the effects mentioned, a plenum might be constructed around the air heating coils. The air itself could then be admitted to the plenum and then to the coils by means of one, or a series, of gooseneck openings located at the top of the plenum. Further, a trap door provided in the floor of the plenum would permit the ready removal of any snow entrained by the incoming air.

Under the arrangements Mr. Rutherford describes, how it is possible to avoid large heat losses to the atmosphere from the mass of water in the heating tower? It is not clear how actual freezing of the water at the upper surface of the tower can be avoided when subzero temperature conditions prevail outside. It is possible, of course, that the agitation of the water caused by the blasting of the return air through it, plus the cascading effect of the water, may discourage this icing action. It would be interesting to have more details on this particular aspect.

The article also states that, in the event of failure of the water pump, the supply fan would automatically cease to operate in order to prevent freezing of the heating coils. In this event, presumably no outside air would be supplied to the mine. Wouldn't this create a critical condition if the underground areas were deprived of outside air for any length of time? If so, it would be of interest to know how it would be proposed to circumvent such a situation.

Inasmuch as the article in general does not mention what the design philosophy is on duplexing of certain critical equipment such as fans and pumps, it is difficult for the reader not intimately familiar with mining problems to evaluate the necessity for providing standby units. What happens, for example, to the water in the heating tower if a failure in the operation of the return air fan suddenly occurs? Presumably, the water could circulate between the coils and the tower until such time as the previously acquired heat stored in the mass of the tower water became completely dissipated through thermal exchange with the outside supply air. When this point is ultimately reached, the question is what is done with the raw outside air when it can be no longer tempered? Wouldn't this compromise the supply of critically needed outdoor air to the mine?

These considerations put aside, there seems to be no question but what the return air has ample capacity to supply the requisite amount of heat to the system.

According to a check we have made on the heat balance, based on the design values given and using standard formulas for total heat and sensible heat, we have arrived at the following results:

1) Total heat loss of return air to water:
$60 \times (1/13.1) \times 225{,}000 \times (26.18 - 15.21) = 11{,}300{,}000$ Btu per hr.

2) Sensible heat gain by water:
$500 \times 1400 \times 9.5 = 6{,}650{,}000$ Btu per hr.

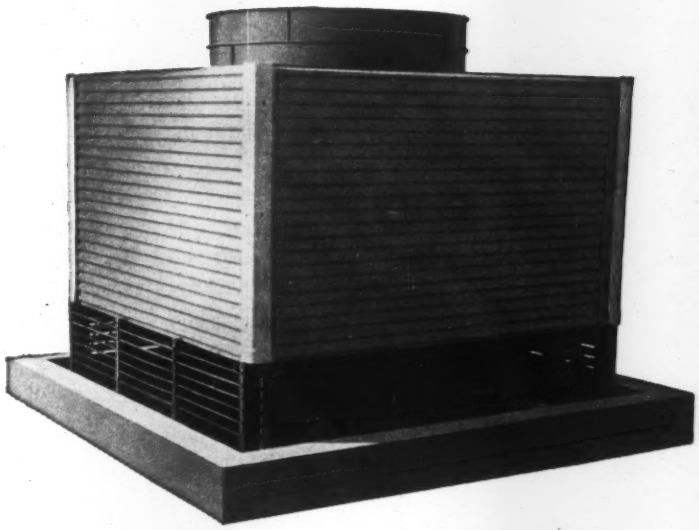
3) Sensible heat gain by outside air:
$60 \times (1/12.8) \times 0.24 \times 125{,}000 \times 50 = 7{,}000{,}000$ Btu per hr.

This would indicate that the return air has more than 1½ times the heat capacity required to heat the outdoor air from −20 F to 30 F. This appears to substantiate the claim made in this connection by Mr. Rutherford.

The minor discrepancies between the results obtained from items (2) and (3) above are, no doubt, due to small variations in values used for the specific weight of air and the specific heat of air in item (3). However, this is as might be expected, since no two designers would probably ever use exactly the same values in computations of this sort.

All of these comments are submitted with a constructive intent, and will, I trust, be construed accordingly. They express my personal views only, and in no way reflect any opinions or statements by the Western Electric Co.

H. Vaugle
Professional Engineer
Western Electric Co.



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GENERAL OFFICES:
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question of the month

"How Should I Ventilate Large Cafeteria Kitchen?"

This question was asked previously in Heating, Piping & Air Conditioning and is repeated here, along with answers that have been received from readers. Other solutions or comments for publication are invited.

"An extensive and complete ventilating system was installed when a modern cafeteria was built three years ago, but the 41 burners in the kitchen, when all are operating, proved to be too much for the system. The temperature in the kitchen is unbearable for the four cooks, bakery personnel, and other occupants. What is the best approach in revising an existing ventilating system in a cafeteria kitchen so that it will perform satisfactorily? I would like to use refrigerated spot cooling to help solve this problem, but it would take many tons of refrigeration capacity to remove the burner load alone. There must be some more practical method than this. I would appreciate seeing how other HPAC readers have attacked similar problems." — T.R.B.

Local Exhaust Ventilation System Has Big Edge over Other Methods

WE HAVE designed kitchen ventilation systems for more than a thousand restaurants throughout Virginia. All of these designs were based on the principles of local exhaust ventilation. The systems which have been installed and operated properly have given very satisfactory service.

The inherent nature of the ventilation problems of commercial kitchens makes the approach employing local exhaust ventilation the most practical. Operation of ranges, ovens, deep fat fryers, and other cooking units produces heat, smoke, grease, and cooking odors which are objectionable to workers and patrons. The heat, smoke, grease, and odors which are released can all be captured and removed from the kitchen by the controlled movement of air into a properly designed local exhaust ventilation system.

The tremendous advantage exhibited by the use of a local exhaust ventilation system over the use of a general ventilation system is that the heat, smoke, grease, and cooking odors are removed at their source and are not allowed to escape into the air of the kitchen. As a consequence, workers will not complain about the heat, grease, and smoke. This material will not accumulate on walls and ceilings (cleaning will be easier; painting will be required less frequently), and customers will not complain about cooking odors upon entering the dining area.

No practical application of general ventilation can achieve these effects in a kitchen. The rate of general ventilation attained in a kitchen employing a local exhaust ventilation system is governed by the quantity of air required to provide effective control. Experience has proven that systems designed on this basis are very satisfactory in hot weather operation. However, some additional load may be imposed on the restaurant heating plant in cold weather operation.

The most practical hood to employ in commercial kitchens has proven to be the semi-canopy type. Less practical, but required in some instances, is the full canopy type. Because the control exhibited by these types of hoods is less effective in the presence of stray or uncontrolled air currents, it has been found necessary to exclude all fans in the kitchen, except the one or ones used to exhaust air through the

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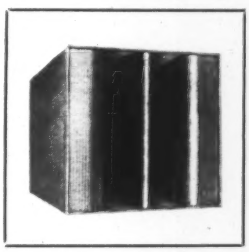

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question of the month

Continued

hood. It has also been found necessary to provide makeup air inlets in locations which will assure an even distribution of air across the face of the hood, with no chance of short-circuiting. Often it is possible to make use of existing windows; sometimes it is necessary to install a supply air system.

The size of the hood required is a function of the size of the cooking units. The hood should cover the units effectively. It is desirable to have an overhang in both length and width. The depth of the hood should be great enough to contain any sudden bursts of steam or smoke until the fan can draw them out. The lower edge of the hood should be as close as possible to the cooking surfaces, while allowing ample room for cooking operations. The quantity of air to be moved to achieve effective control depends on the face area of the hood, the type of cooking unit to be hooded, and the ceiling height of the kitchen. Experience has proven this to be a very critical value.

The size of the ductwork required is a function of the quantity of air to be moved. Duct velocities should be maintained high enough to minimize the possibility of grease building up on the inside walls. Even under the best conditions, the problem of grease collecting on the inside walls of ductwork can become acute. The most practical solution to this problem is the installation of commercially available grease filters. The number of filters required depends upon the size used and the quantity of air to be exhausted through the hood. The sizes of filters to be used and the arrangement of filters in the hood depend, of course, upon the size and type of hood used. Additional advantages of the use of grease filters are: when properly located, they tend to even out the distribution of air flowing through the face of the hood; also, they serve as an effective fire-stop against the flash fires that sometimes occur in cooking.

The fan is the heart of the ventilation system. Its selection should be made carefully. It must have adequate capacity to pull the required amount of air through the system against the combined resistance of the hood, ductwork, grease filters, and supply air system. Either a propeller or a centrifugal fan, of proper rating, can be used in a given system; however, the lower noise level, the greater flexibility of operation, and the only slightly higher first cost of the centrifugal fan make it the better choice.

In answer to the specific question asked, the best approach to revising the existing system would be to obtain the answers to the following questions:

1) What are the types and the locations of the cooking units in the floor plan of the kitchen? What is the height of the kitchen ceiling?

2) Are the units grouped in a battery along a wall, or are they in an island away from the walls? If the latter is true, can they be relocated along a wall?

3) Is there a hood? Is it adequate? Is the ductwork of good design?

4) Is the hood equipped with grease filters? Is there enough filter capacity? Are the filters installed so as to give even distribution of air into the hood?

5) Is there provision for supplying makeup air? Is it adequate? Are the openings located so as to allow an even flow of air into the hood, without cross drafts or short-circuiting?

6) Are there other exhaust fans working against the hood fan?

7) Is the hood fan capable of moving the required amount of air against the combined resistance of the system?

Once these answers have been obtained, the problem is resolved into one of designing a local exhaust ventilation system to fit the conditions found.

HARRY E. SEIFERT
Director, Bureau of Industrial Hygiene
Department of Health
Commonwealth of Virginia

READER ASKS—

"Will Higher Temperature Cause Corrosion, Other Problems?"

"I have charge of the operation and maintenance of hot water boilers which supply heat and hot water to apartment buildings. The hot water is supplied by means of boiler water circulating through coils in a storage tank. The boilers have been operating at temperatures of 190 to 200 F and at a water pressure of 22 psi. There has been trouble supplying hot water at the proper temperature due to a load which is now larger than originally designed. One solution considered is that of raising the boiler temperature to 210 F. Other operating conditions would remain the same. Are there any corrosion or other problems which will arise due to the raising of the water temperature to 210 F?"—M.U.

• *YOU ARE INVITED to contribute a question for publication or an answer to a published question. Write: The Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.*

NEW from Superior...

a boiler with Venturi-Action Mixing Tube

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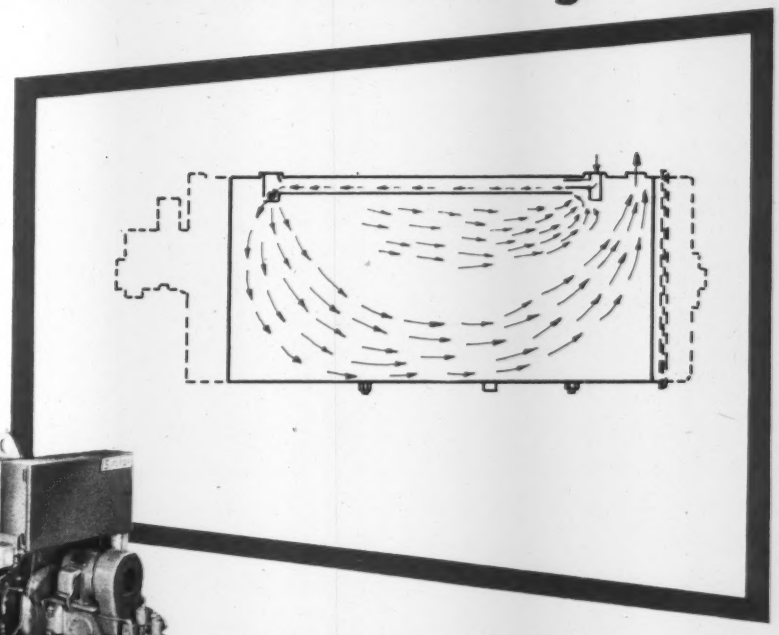
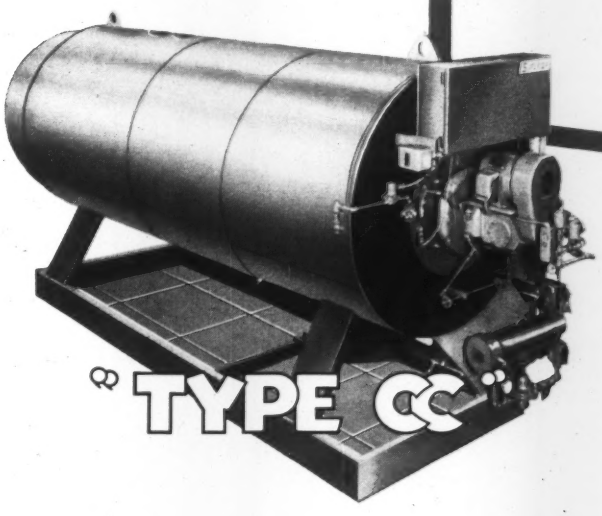
Hot Water Heating





For details of the Type CC, the answer to trouble-free hot water heating, write for Catalog CC-14.

Unequal circulation within the boiler . . . a problem of serious consequence in hot water heating . . . has been overcome by a newly developed *Venturi-Action Mixing Tube* which is an integral feature of the new Type CC. The tube plays a triple role:

(1) It starts by mixing entrained water from the boiler with water entering the boiler.

(2) As this mixture travels through the tube, its temperature is further modified by surrounding water.

(3) Jet action at the end of the tube, where flow is directed down and outward at the boiler front, provides an unequalled full-length boiler circulation pattern.

This flow pattern was carefully traced time and again by means of thermo-couples which proved that the mixing action achieved was unequalled in any other hot water boiler.

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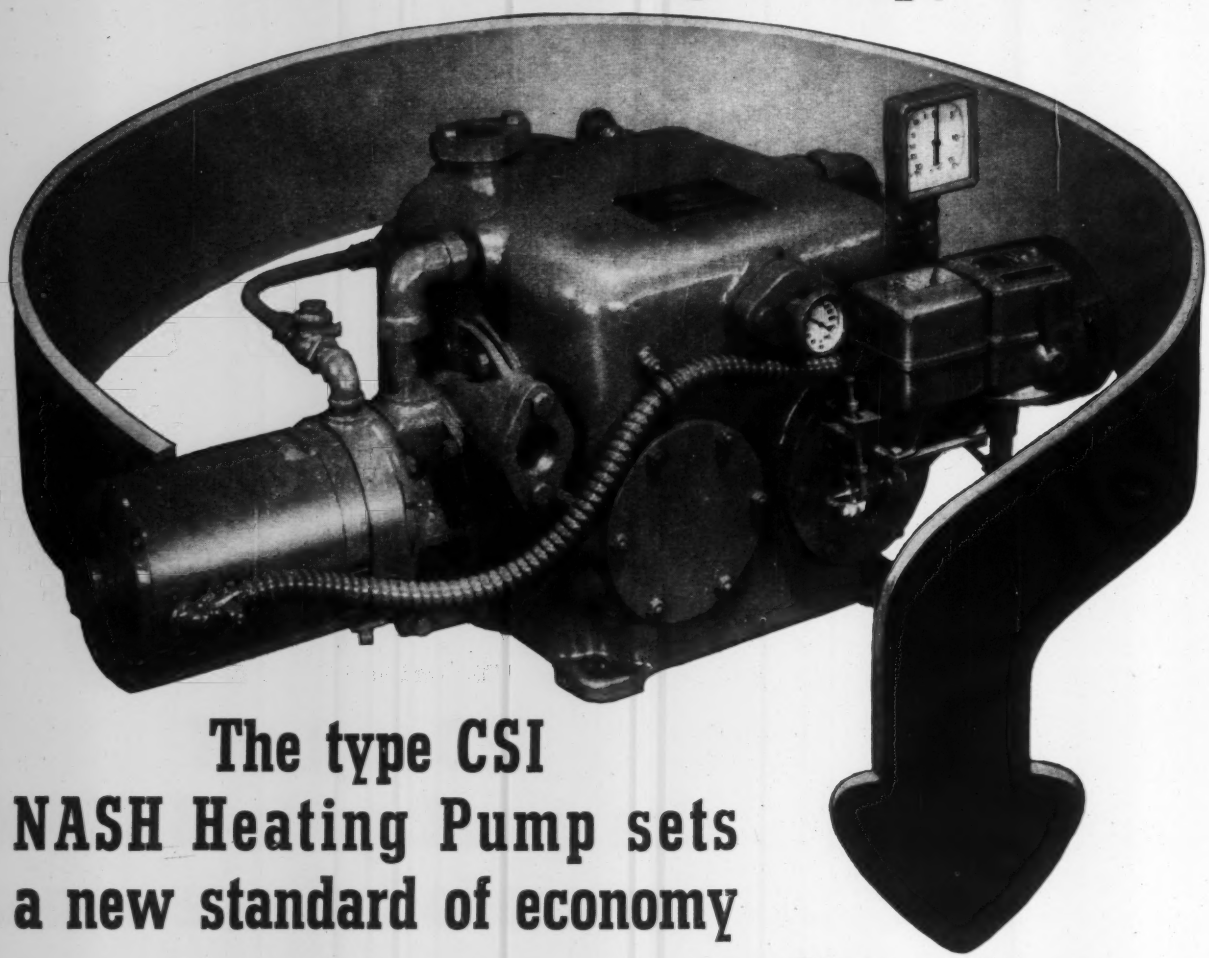

The type CSI NASH Heating Pump sets a new standard of economy

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The Nash CSI has generous air capacity and features a wide choice of water capacities and discharge pressures. The right combination of capacities is at hand to match the requirements of the job. It is no longer necessary to pay extra for a pump with excessive water capacity, excessive discharge pressure, or in an attempt to get adequate air capacity.

With this advanced design, Architects, Engineers and Contractors will find answers to many heating system problems. Send for bulletin now.

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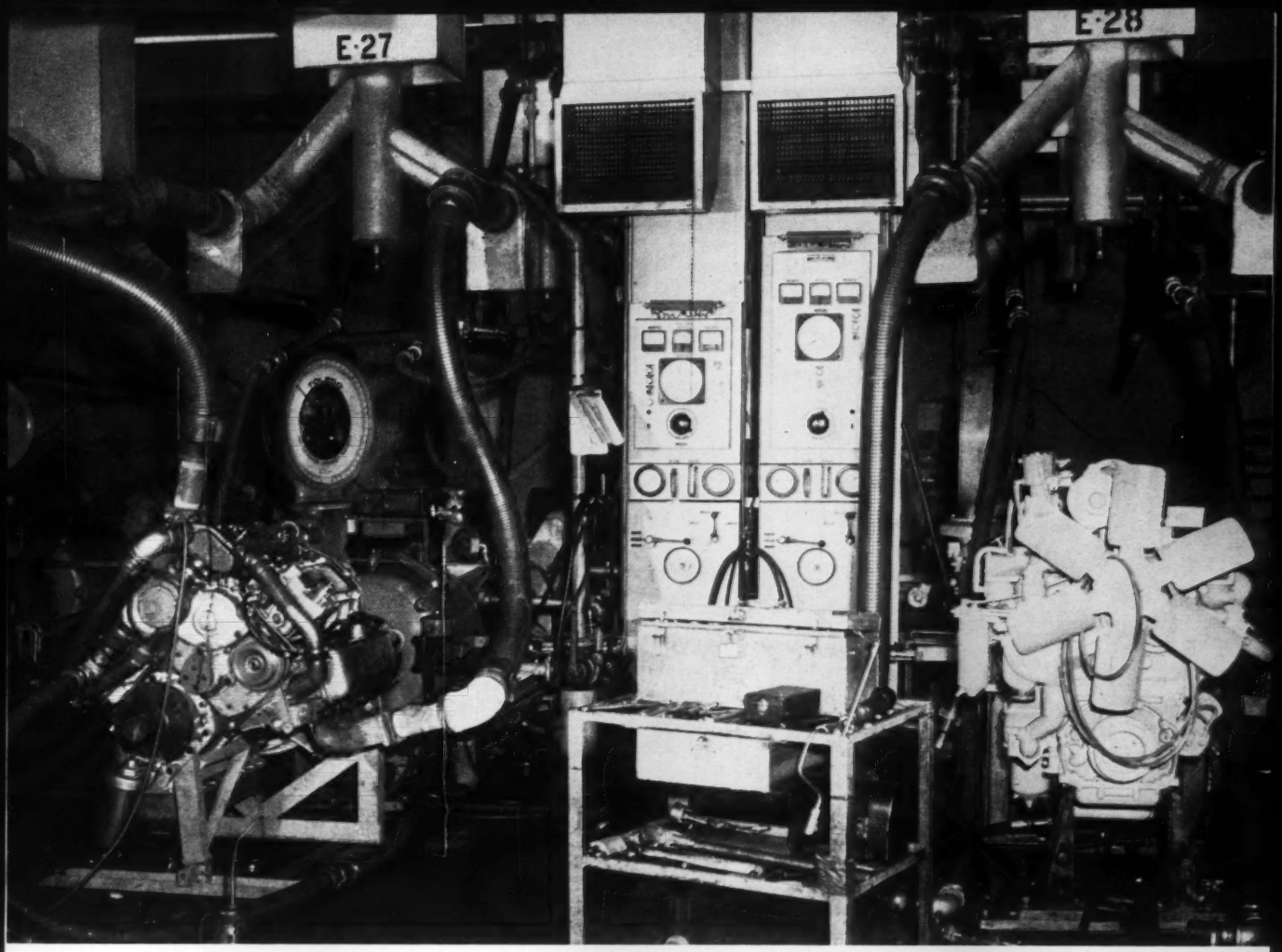
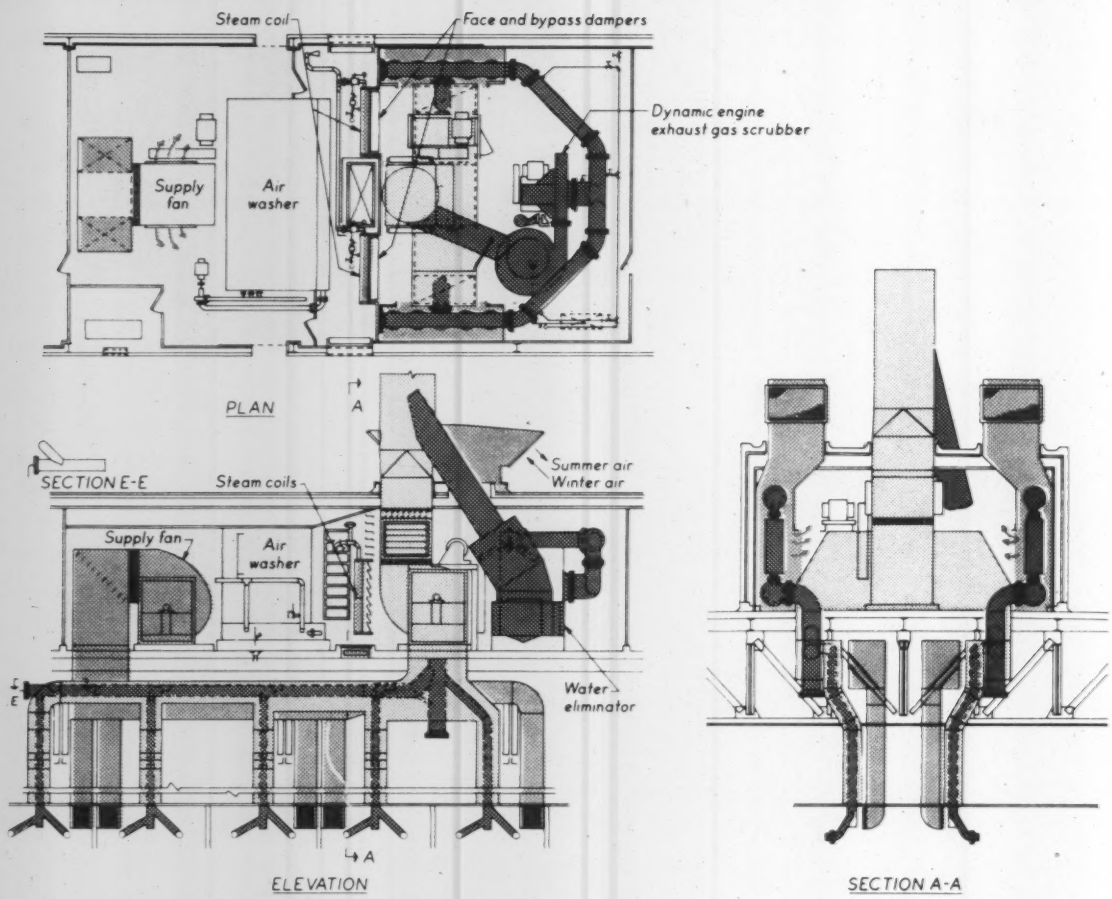


ENGINE TEST STANDS have outside air supply ducts and grilles adjustable in both horizontal and vertical planes. Engine exhaust line emerges from room air discharge duct. Operator adjusts horizontal vanes which deliver air either directly in front of stand or in any other location in front of duct

Ultra-Modern Engine Plant Demands Unique Heating, Ventilating Systems

• Revolutionary engine assembly and test facilities incorporated in the recently completed addition to General Motors Corp.'s Detroit Diesel Engine Div. plant required the installation of commensurate heating and ventilating systems. With a design goal of occupant comfort and increased employee efficiency, the engineers devised truly unique applications of high velocity systems which deliver air at 1800 to 2000 fpm at an elevation 10 ft above the plant floor level. The systems now installed match—in modernization and advanced thinking—the forward development in the plant's production line. Worker complaints have been practically nil and management has reaped tangible returns evidenced in attendance, job attitude, and overall contentment. Lester S. Ries, author of this article, is a member of HPAC's board of consulting and contributing editors. ▶▶▶

In winter —



FOR WINTERTIME OPERATION, outdoor air (green) is preheated by passing over hot engine exhaust silencers before final heating at steam coil. Engine exhaust area is represented by dark gray, while room exhaust is light gray

BY LESTER S. RIES
Consulting Engineer

THE NEW 300,000 sq ft plant addition to the Detroit Diesel Engine Div., General Motors Corp. completed within the past two years houses engine assembly and engine test facilities. Incorporated within the addition are several unusual forward developments in product transfer equipment including radio frequency controlled conveyors and overhead engine assembly conveyors with semi-automatic transfer stations.

The challenge posed by the installation of ultra-modern developments in the assembly line prompted the investigation of several basic heating and ventilating designs to produce a system commensurate with the achievement in the production phase.

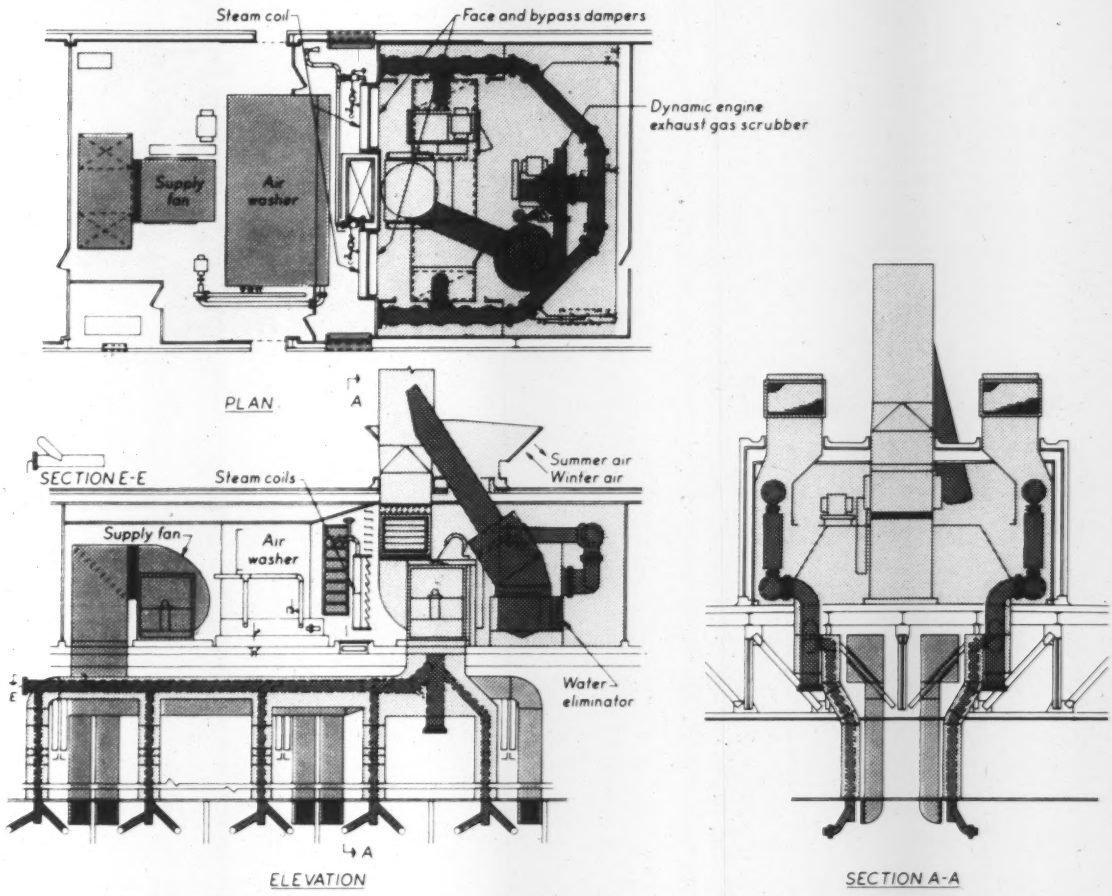
Primary concern was given to occupant physiological well-being and comfort. At the same time, emphasis was placed on increased employee efficiency. It must be stated here that management has received almost no complaint from the occupants after the initial period of system balancing. This fact is of major importance in view of the objectives sought.

The fundamental principle of the system installed depends on the delivery of high velocity air at 1800 to 2000 fpm at an elevation 10 ft above the floor.

The heating and ventilating of this addition necessarily comprises two distinct areas that required individual planning and treatment. Area 1 is that portion of the whole area housing engine assembly, subassembly, package power testing, painting, boxing and crating, shipping, and truckwell and trainwell. This is about 90 percent of the whole. Area 2 is a completely walled-in space (approximately 25,000 sq ft) known as the basic engine test area.

The Area 1 addition is a building of conventional factory type construction having the bottom chord of the steel roof truss 16 ft above the floor and the

In summer —



FOR SUMMERTIME OPERATION, winter air supply duct is used for room air exhaust (light gray). Thus, operation of same equipment is reversed to achieve savings and maximum worker comfort

top of the monitors extending 10 ft above the roof. The total building volume is 7.5 million cu ft. However, the 10 ft high air delivery level significantly shrinks the ventilated building volume to 2.75 million cu ft (about 37 percent of the whole), thereby reducing the quantity of air that must be handled by the equipment.

Nineteen package steam unit heaters, each rated at 20,000 cfm, serve the large space housing the assembly, boxing, crating and shipping, and stock areas. Each unit discharges through two ducts, each of which delivers 10,000 cfm through an 18 × 36 in. outlet at 1800 to 2000 fpm 10 ft above the floor. The outlet is equipped with adjustable horizontal and vertical louvers that direct and distribute the air.

The units are spaced approximately 60 ft apart north and south and about 130 ft apart east and west. Discharge is directed from west to east throughout the area except at the northwest corner of the building where four ducts are reversed to divert 40,000 cfm westward toward the unprotected outside wall of the building. Even though the air travels almost 100 ft from the outlet over the heads of the operators, the unprotected outside wall is sufficiently blanketed with warm air to provide a comfortable place in which to work.

Control Each Unit Independently

Each package unit heater has its independent control, the thermostat being located on a building column about 7½ ft above the operating floor. The units are mounted in the monitor or truss space and the 24 in. × 100 in. return air duct is located below the 16 ft elevation of the bottom chord of the truss.

Each unit contains 12 grid type filters reinforced with expanded plastic coated metal that can be installed from the side through the sheet metal casing

INTERIOR VIEW shows portion of engine exhaust gas scrubber (left), silencer group (right), room air exhaust fan and plenum (center), motor operated louvers (upper left). Winter air is drawn over hot silencers before tempering

onto holding rails. A drain pan at the base of the casing between the filters and the steam coil is connected with a drain to the roof conduit. This facilitates cleaning the coil and filters in place.

The package power and multiple engine test areas, enclosed on three sides, are located on the north end of the assembly space and adjacent to the paint spray booths. Here, certain modifications were made. Ventilation equipment is installed in a penthouse directly over this space and includes an air washer to provide evaporative cooling in summer. The summer design temperature in Detroit in 95 F dry bulb, 73 F wet bulb. Although the washer is not capable of reducing the dry bulb temperature to the wet bulb reading, sufficient depression of the dry bulb can be obtained to provide comfort.

During cold weather the washer is drained and the air is tempered through a steam coil. Final temperature is controlled with face and bypass dampers. Here, too, the supply outlets are located 10 ft above the floor, but eight are installed on the north wall and eight on the south wall.

The high velocity air streams collide along a median, then flow east over the multiple engine test area and out through the open end of the room to large paint spray booths located nearby. Thus, a satisfactory environment has been established for two engine test areas and makeup air has been furnished to the spray booths, thereby assuring their efficient operation.

This area is typical of the new assembly layout wherein outdoor air is used as makeup and all exhaust is passed through processing operations. Roof exhausters are installed above both engine test floors for use during periods of special testing.

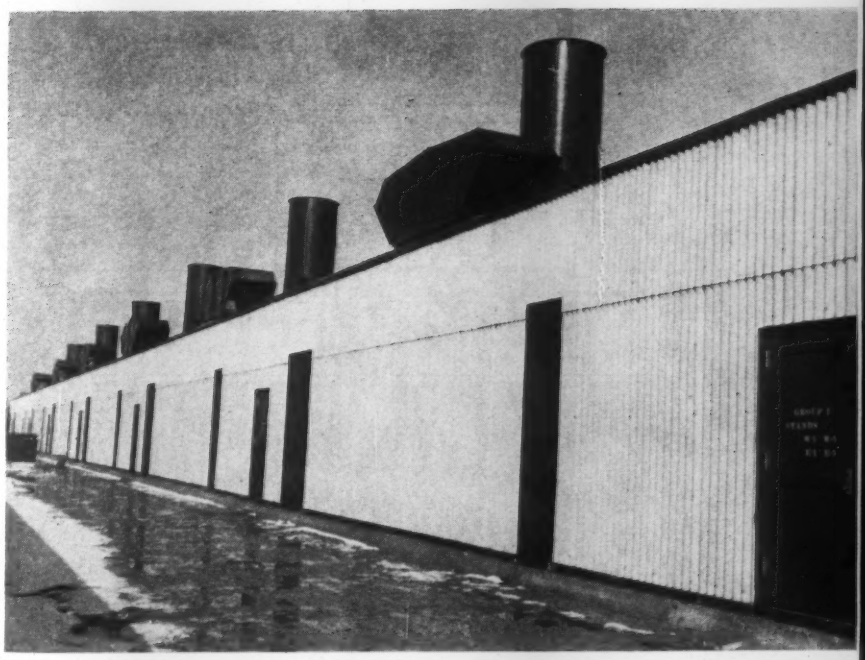
Warm Air Curtain Keeps Out Cold Air

The four-stall truckwell area is equipped with four heaters interconnected with valves that override their thermostats, open the steam valves, and take 100 percent outside air when the doors are opened. This warm air curtain performs the satisfactory function of keeping the cold air out and the warm air in. Two 50,000 Btu per hr projection heaters installed in conventional manner for truckwell service were found to be unnecessary.

If the air supply units in the rest of the building are not running, a vacuum will result and the assembly areas will develop drafty and uncomfortable conditions — even when the truckwell heaters are in operation. The makeup air in the assembly area to equal the exhaust is about 260,000 cfm.

Ventilate Engine Test Area

Area 2, the completely walled-in basic test area, comprises seven groups of 10 engine test stands each. It is 360 ft long × 70 ft wide. The bottom chord of the truss is 17 ft above the floor and the roof is 25 ft high. Each of the engine test stand groups is serviced with a 60,000 cfm supply fan, a 45,000 cfm exhaust fan, and a dynamic engine exhaust gas scrubber. This equipment is located on the floor of the



CYLINDRICAL STACKS mix, disperse engine exhaust gas and room air discharge to atmosphere. Double-ended transition units bring in winter air, exhaust summer room air. In summer, procedure is reversed

penthouse which is a concrete slab 25 ft wide and continues the full length of 360 ft.

Seventy engines with a total power absorption potential of 35,000 hp can be tested simultaneously. Engine combustion air required is about 120,000 cfm. Design data was obtained in a pilot setup for the basic test area early in the planning stage of the building. GM's personnel services and the industrial hygiene department collaborated in crystallizing the final design.

The ventilation installation is based on a design factor of 60 percent of engine total test loading. This factor was also used in evaluating requirements for fuel supply, lubricating oils, and engine dynamometer water supply. The engine exhaust gas scrubber is rated at 15,000 cfm at a static pressure of 3 in. water gage. Final cleansing of the exhaust gases is performed by a bank of sinuous filters. An electrostatic precipitator used in the pilot setup was effective but was not used in the final installation as the plates shorted because of the moisture carryover of the carbon particles.

Collection of the solids in the exhaust gases is begun in the scrubber where the gas is precooled by a water spray nozzle to about 200 F from an initial temperature of 800 to 900 F. A second spray nozzle causes a further reduction to about 135 F. Blowdown water from the dynamometer cooling tower is used (after treatment with liquid sodium hydroxide to pH 8) as the spray water in the scrubbing system.

The scrubbing effluent is drained by gravity into a common header which services the seven dynamic scrubbers. A flow meter, calibrated in gpm, is interposed in the drain line to indicate the volume of water being sprayed into the exhaust gas system. When the meter shows a decrease in flow, the nozzles are removed and cleaned.

Since the pH is controlled and the solids content is acceptable to the municipal sewers, the scrubbing effluent is finally disposed of without further treatment directly into the sanitary sewer system.

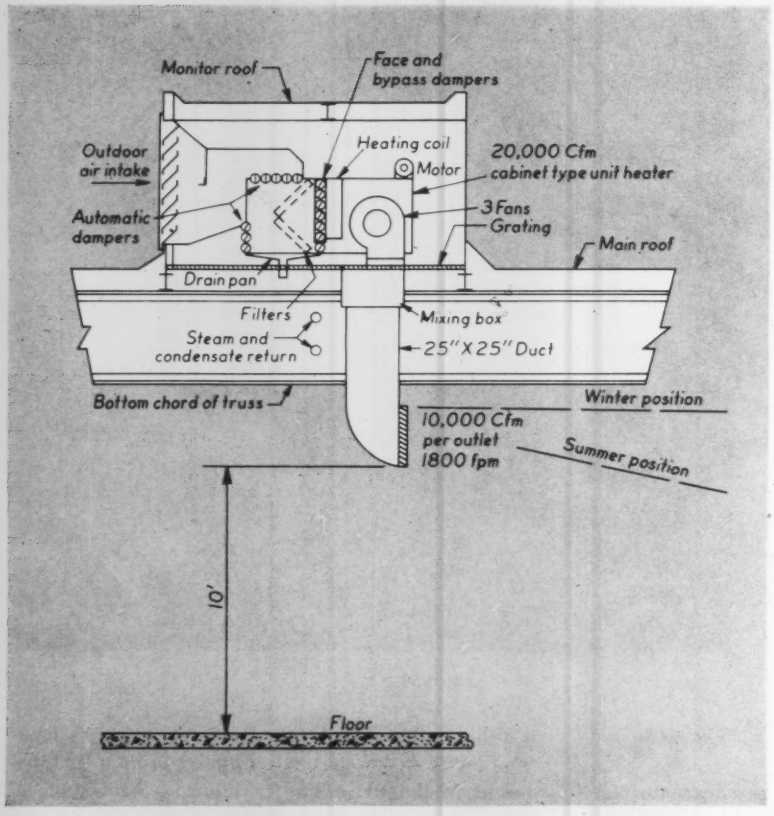
The inlet ducts to the supply fan are located on the penthouse roof for winter operation and through side wall louvers for summer conditions. All outside air is used at all times — winter and summer.

Temper Supply Air in Winter

In cold weather the supply is first tempered by being drawn over a bank of mufflers heated by the engine exhaust gas from the test block on its way to the scrubber. The air then passes through steam coils and continues to a double-inlet fan to the supply ducts serving the 10 engine test stands.

Supply air is distributed through an outlet at each engine test stand, the vanes of which are adjustable in four directions. Vertical distribution can be controlled by the engine test operator by manipulation of a chain attached to the horizontal vane assembly. Horizontal dispersion is controlled by vertical vanes, each of which is individually adjustable.

The room air exhaust duct is also 10 ft above the floor and is within 3 ft of the supply. This arrange-



AIR FLOW DIAGRAM illustrates comparative paths of high velocity air in summer, winter positions. Air is delivered at 10 ft level for worker comfort

ment is as effective as it is revolutionary. Supply air travels 30 ft across the room, strikes the wall, and returns to the exhaust duct which also houses the engine exhaust gas stack.

Engine exhaust gas is directed through the muffler group while the room air discharge is drawn through the exhaust fan to a point where it mixes with the engine exhaust gases after they leave the scrubber. The resulting combination provides a stack emission almost devoid of combustion products.

Winter Inlets Are Summer Exhaust Outlets

In summer operation the winter outdoor air inlets on the penthouse roof become the room air exhaust outlets. The summer outdoor air supply is taken through the side of the penthouse, thus bypassing the steam coils. Air is passed through the spray type air washer where it is nearly saturated. Adiabatic heat interchange takes place and the wet bulb is 15 to 20 F below the prevailing dry bulb temperature.

Air delivered to the test area is 10 to 15 F below body skin temperature and, although it is nearly saturated, it can cool the body by convection when passed over it at a high velocity as directed by changing the louvers on the outlets. This air stream then continues past the operator and over the engine under test. It picks up heat rapidly, thus lowering the temperature in that area.

System Weathers Sweltering 1959 Summer

The air handling systems in the test rooms have provided a satisfactory condition at all times. During the unusually hot and humid summer of 1959 the test room temperature was maintained at a comfortable level by the combination of the evaporative coolers and the high velocity air motion of the air supply systems.

Because the heating and ventilating design and equipment were selected to improve the conditions at the level at which the operators worked, the tangible returns have more than justified the engineering detail involved. Employee reaction, as reflected in attendance, job attitude, and overall contentment, has justified the design engineers' concern for incorporating these improvements in the plan.

The author gratefully acknowledges the cooperation and assistance of C. T. Gruner, Detroit Diesel Engine Div., and K. E. Robinson, General Motors' industrial hygiene department, in the preparation of this article.

HOW TEMPERATURE, TREATMENT, AND VELOCITY OF POTABLE WATER AFFECT CORROSION OF COPPER AND ITS ALLOYS

Tests Show Effects of Water Quality At Various Temperatures, Velocities

• Tests conducted at Michigan State University prove conclusively that different temperatures, velocities, and water qualities have different effects on the corrosion of copper and its alloys. Briefly, the effects of velocity and temperature on copper tube using sodium zeolite softened water and blended waters of 60 and 110 ppm hardness are:

1) Maximum corrosion for a given velocity does not occur at the highest temperature, but rather at about 170 F.

2) Of the three types of water, corrosion is least noticeable with sodium zeolite softened water blended back to 110 ppm.

3) The amount of corrosion increases with velocity increase. In general, if velocities are below 5 fps, corrosion rates are not excessive.

4) Corrosion-erosion is a composite effect resulting from high temperatures, high velocities, and soft water compositions.

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In one of the three test panels employed in the corrosion studies at Michigan State University, sodium zeolite softened water was utilized. In each of the other two panels, different blends of sodium zeolite softened and of hard water were tested. This article discusses the effect of this type of softened water and of the blended "hard waters" on the corrosion of the copper tube used in the test panels.

The zeolite softening process consists of passing raw water through a bed of insoluble, solid material known as an ion exchange resin or as a zeolite. The exchange medium can be either a naturally occurring or a synthetically produced material which has the property of exchanging monovalent ions from its structure with the positive ions of two or more charges found in the water.

The cycle of usage for an exchange resin involves two steps: (1) an exchange step for softening in which the sodium ions of the resin or zeolite are replaced by the calcium and magnesium ions of the untreated water; and (2) an exchange step for regeneration which consists of a backwash to remove solids adhering to the resin bed, a brine wash to regenerate the sodium form of the resin, and a wash to remove excess chlorides.

In this sodium zeolite process, the effluent softened water contains sodium ions equivalent to the number of calcium and magnesium ions in the untreated water. The process reduces the hardness to approximately zero, compared to a hardness of 10 to 30 ppm for the lime soda process. An important disadvantage of the zeolite process is that the hardness is reduced without a parallel reduction in alkalinity, dissolved gases, and total solids.

In the research on the copper corrosion at Michigan State in which the sodium zeolite waters were used, laboratory studies were conducted on the effects caused by various ions in solution on overall corrosion rates.

With sodium zeolite softened water of about zero hardness, the problems of maintaining film formation were very difficult. The Langelier Index for the waters tested was negative. Blending hard water with sodium zeolite softened water to maintain a residual hardness in a service water distribution system appears to offer a reasonable answer for protective film formation. For these studies, the water passed through one panel was zero hardness sodium zeolite softened water, a second test panel was operated by blending hard water with sodium

This is the fourth in a series of articles. The first three appeared in the January, March, and April issues.

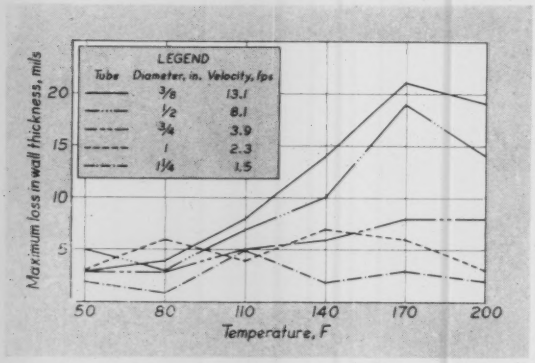


Fig. 1

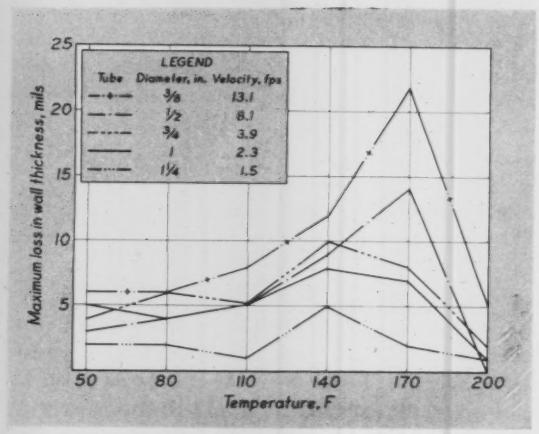


Fig. 2

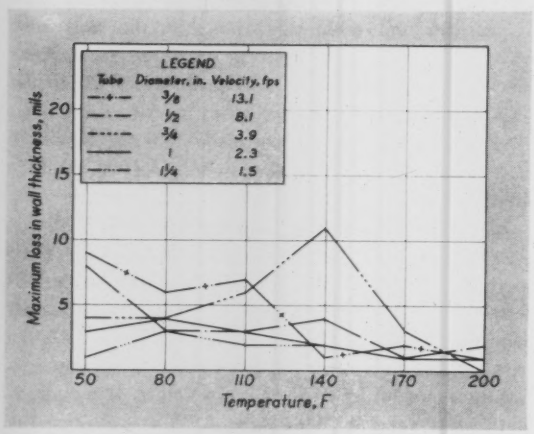


Fig. 3

1-6 RELATIVE EFFECTS of temperatures, velocities on loss in wall thickness of copper tube are shown in these charts. Figs. 1 and 4 are for Main Test Panel No. 1; Figs. 2 and 5 represent MTP No. 6; Figs. 3 and 6 are for MTP No. 3A

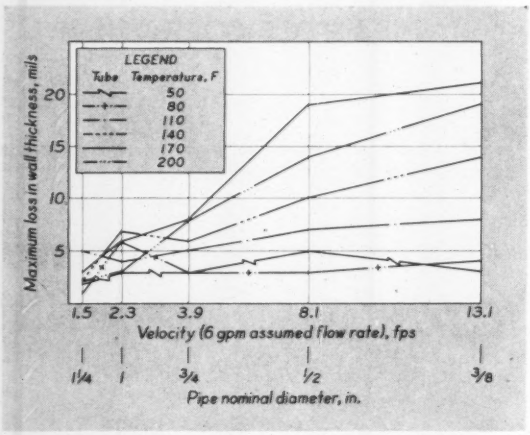


Fig. 4

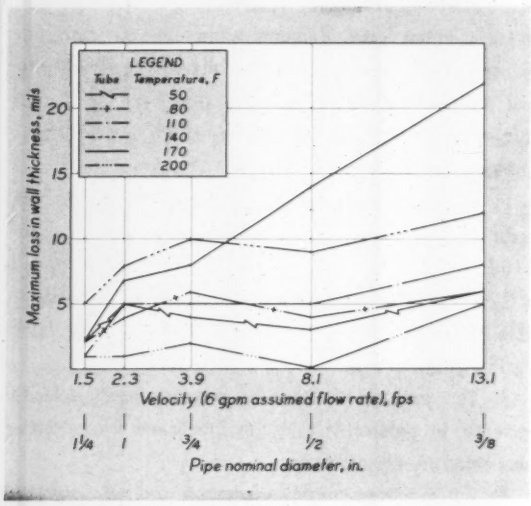


Fig. 5

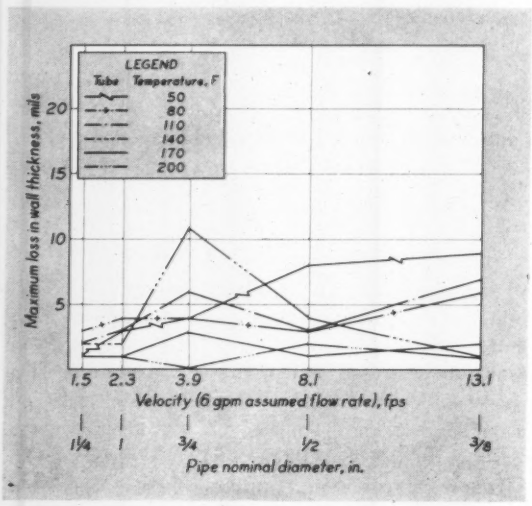


Fig. 6

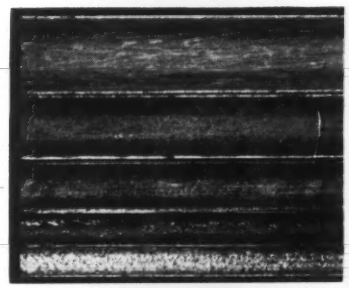


Fig. 7

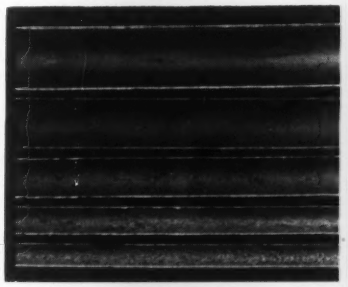


Fig. 8

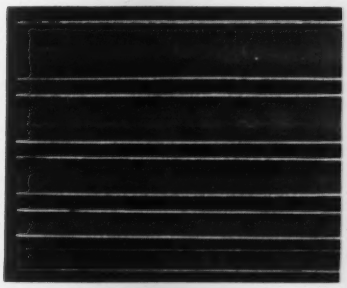


Fig. 9

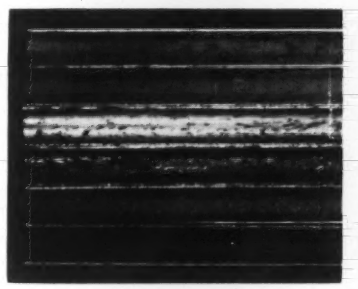


Fig. 10

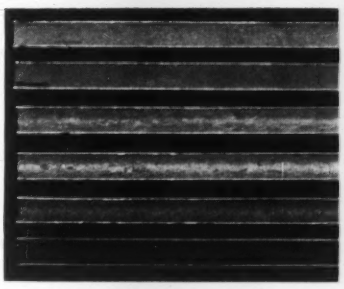


Fig. 11

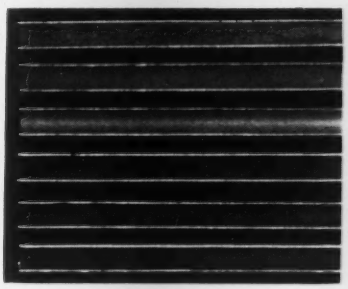


Fig. 12

7-12 ABOVE COPPER TUBE SECTIONS were subjected to the following operating conditions: Fig. 7 — varying velocities, 140 F, zero hardness; Fig. 8 — varying velocities, 140 F, 60 ppm hardness; Fig. 9 — varying velocities, 140 F, 110 ppm hardness; Fig. 10 — varying temperatures at 8.1 fps, zero hardness; Fig. 11 — varying temperatures at 8.1 fps, 60 ppm hardness; Fig. 12 — varying temperatures at 8.1 fps, 110 ppm hardness

zeolite water to an effluent of a total hardness of 60 ppm, and the third panel had a blend of waters of 110 ppm.

These three main test panels were constructed of copper tube and were assembled as described in the article, *Monitoring System Reveals Effects of Different Operating Conditions*, in the April issue. Water for each of these three panels came from the same line, with proper valving of hard water to produce the desired hardness in two of the panels. Each panel remained on stream for 17 months (498 days). When it appeared that an additional four months of service might result in a failure, a panel was removed from operation. This decision was justified, since observations showed that the minimum remaining wall thickness in some areas was only 0.010 in.

After a panel had been disassembled for the last time, the 30 tube samples were inspected in the same manner as had been employed for the

TABLE 1 — THESE COMMENTS on boroscope observations of copper tube sections of Main Test Panel No. 1 were made by Copper and Brass Research Association members at final inspection after 17 months' operation. Tube handled sodium zeolite softened water

Temperature, F	Tube diameter, in.	Comments
50	1¼	Heavy brown scale; no apparent attack.
	1	Same.
	¾	Same.
	½	Spotty brown scale; no apparent attack.
	⅜	*Bright etched copper surface with small islands of scale.
80	1¼	Uniform brown green film; no apparent corrosion.
	1	Same.
	¾	Same.
	½	Same.
	⅜	Same.
110	1¼	*Bright etched surface with islands of brown scale.
	1	*Same, but more etching.
	¾	*Same, but with progressively greater etching.
	½	*Same, with progressively greater etching.
	⅜	*Deeply etched surface with islands of brownish scale.
140	1¼	*Deeply etched and roughened surface throughout tube, with some bright spots.
	1	*Same, but progressively more effect.
	¾	*Same.
	½	*Same.
	⅜	*Definite impingement pitting.
170	1¼	*Slight velocity effect at entrance; roughened surface with thin brownish film.
	1	*Same.
	¾	*Same, but rougher and some bright etched spots.
	½	*Same, but worse.
	⅜	*Very rough, with bright bottoms of pits.
200	1¼	*Heavy, very dark scale; some slight surface pitting.
	1	*Inlet attack for about ⅜ in.; then same as above.
	¾	*Same, inlet attack in about 1 in.
	½	*Heavy brown coating; definite but slight erosion.
	⅜	*Same, but worse.

*Evidence of pitting.

TABLE 2 — BINOCULAR-MICROSCOPIC observations made on copper tube specimens are listed below for MTP No. 1 handling sodium zeolite softened water

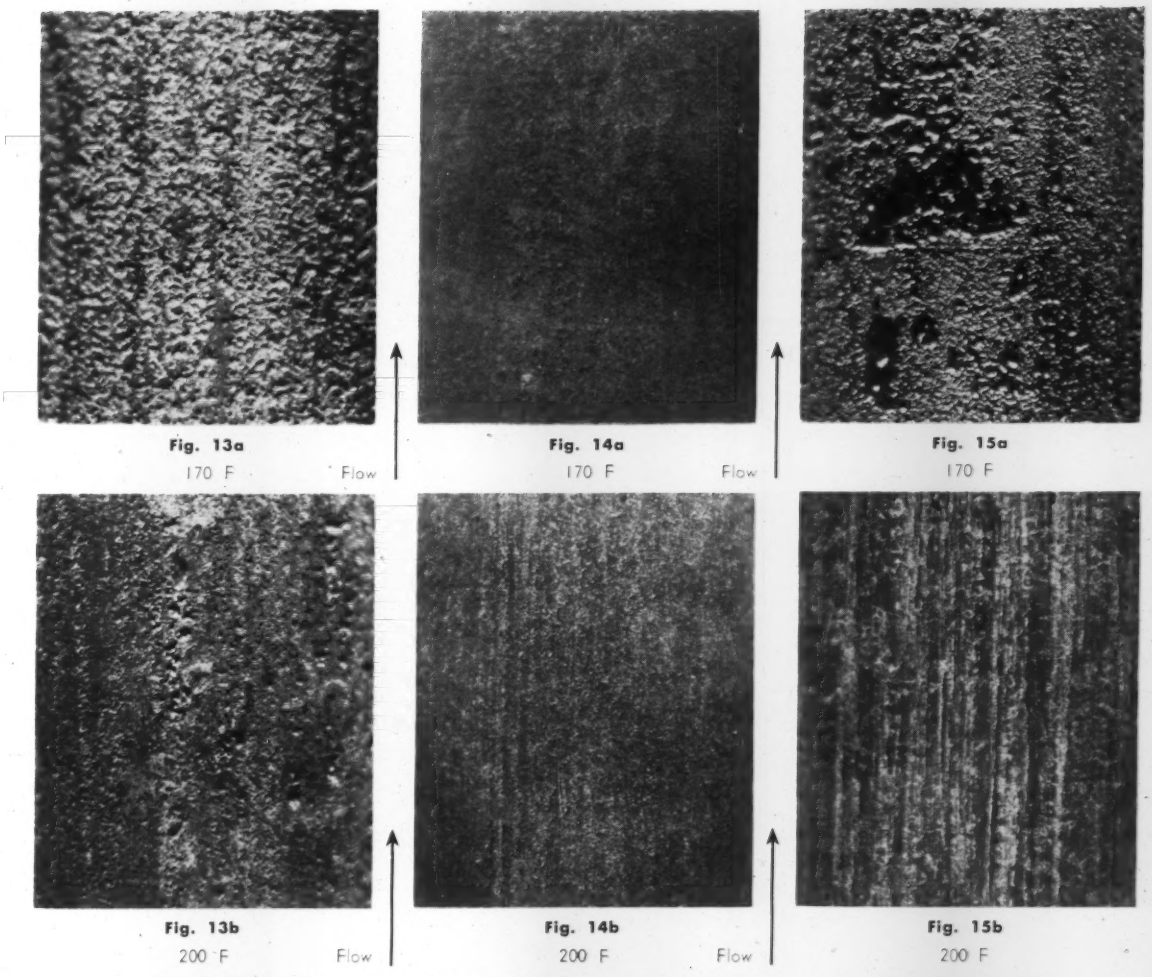
Temperature, F	Tube diameter, in.	Observed deposit	Direction of flow indicated?	Observations of etched sample
50	⅜	Light brown; large anodic areas; small cathodic	Yes	General corrosion; stratified islands.
	½	Light brown; large anodic areas; light film overall.	Not clear	General corrosion; islands.
	¾	Light brown; anodic and cathodic areas equal.	No	General corrosion; islands.
	1	Light brown.	No	Slight general corrosion; small islands; minute pits.
	1¼	Light brown; mottled light and dark.	No	Very slight general corrosion; very small islands.
80	⅜	Light red-brown; single anodic line entire length.	Not clear	General pitting, some on effluent end and side of islands
	½	Light red-brown; uniform.	Not clear	General pitting; some streaked corrosion
	¾	Light red-brown; numerous small streaked anodic areas.	Yes	General pitting; streaked
	1	Light red-brown; some large long anodic areas; numerous small streaked anodic areas; mottled light and dark.	Yes	General corrosion; islands; pitting on islands
	1¼	Light brown; mottled light and dark.	Not clear	Some general corrosion; few small islands
110	⅜	Light brown on island; large anodic area; cathodic islands with slight streaked deposit.	Yes	General corrosion; large islands; pitting on islands; gouging on effluent side of islands
	½	Same; larger areas of light deposit in anodic area.	Yes	Small island; same as ⅜ in.
	¾	Same; less contrast between anodic.	Yes	General corrosion; stratified islands; gouging as above; wrinkling.
	1	Same; more islands; some wrinkles.	Yes	Same as ¾ in.; choppy wrinkles; large pits.
110	1¼	Stratified deposits; varying shades of brown; pits obvious.	Not obvious	General pitting; islands beneath level of pitting.
140	⅜	Very small amount of light red-brown.	Yes	General corrosion; extreme gouged effect in direction of flow.
	½	Red-brown; streaked light and dark; longitudinal.	Yes	General corrosion; some deeply gouged places as in ⅜ in.
	¾	Same; less pronounced.	Yes	General corrosion; long shallow clean valleys; blotchy corroded areas under deposits.
	1	Red-brown; streaked light and dark; slight deposits in anodic areas.	Not obvious	General roughening; alternate clean and rough areas.
	1¼	Same; small anodic areas.	Not obvious	Same as 1 in., but to a lesser degree.
170	⅜	Pits; purplish; red deposit on cathodic peaks.	Yes	Considerable general pitting; gouged effect in direction of flow; rounded pits clean.
	½	Same; less pronounced.	Yes	Same as ⅜ in.; less pronounced.
	¾	Light reddish-brown on islands; similar to 140 F, 1 in.	Not clear	General roughening; some smooth rounded areas.
	1	Same; slight deposit in anodic areas.	Not clear	General corrosion; some islands.
	1¼	Same; less pronounced.	No	General corrosion; numerous pinpoint islands.
200	⅜	Light reddish and deep brown on cathodic peaks; slight deposit in anodic pits.	Yes	General corrosion as in 170 F, ⅜ in., but not as severe.
	½	Light reddish, covered by deep brown areas of rounded anodic pits.	Yes	General elongated pitting; not as severe as ⅜ in.
	¾	Deep brown; some anodic areas	Yes	General rounded pitting; large clean gouged areas.
	1	Deep brown overall; some areas smooth (anodic).	No	General minute pitting.
	1¼	Same.	Not clear	Same; pitting, but less pronounced.

regular four-month inspections. The tubes were then sectioned for visual observations and measurements. The extent of corrosion was evaluated from the remaining wall thicknesses using gravimetric, micrometric, and radiographic measurements.

The critical nature of temperature and of velocity on the corrosion of copper by sodium zeolite softened water and with blended water is well illustrated in Figs. 1 through 6. Maximum loss in wall thickness is plotted *vs* velocity and temperature. These losses

TABLE 3 — BOROSCOPE OBSERVATIONS of copper tube sections of MTP No. 6 yielded these comments. Operation was with sodium zeolite softened water blended with 60 ppm hardness water for 17 months

Temperature, F	Tube diameter, in.	Comments
50	⅜	Olive drab thin film.
	Rest	Thin brown deposit.
80	⅜	Thin greenish brown film.
	½	Thin greenish brown film.
	¾	Thin greenish brown film.
	1	Bright greenish brown scale; patches of brown scale.
	1¼	Bright greenish brown scale; patches of brown scale.
110	⅜	Bright metal surface; slight attack.
	½	Same; few patches of heavy deposits.
	¾	Brown film; no attack.
	1	Brown film; no attack.
	1¼	Thin greenish brown film.
140	⅜	Small patches of dark brown deposit; grooved attack.
	½	Same.
	¾	Thin reddish brown film; nodules of dark brown deposit.
	1	Thin brown film; no attack.
	1¼	Thin brown film; no attack.
170	⅜	Greenish brown deposits; severe pitting.
	½	Same.
	¾	Thin greenish brown film; no attack.
	1	Streaked brown film; no attack.
	1¼	Thin reddish brown film; no attack.
200	⅜	Thin greenish brown film; slight attack.
	½	Dark black film; inlet attack.
	¾	Heavy black film; no attack.
	1	Same.
	1¼	Same.



13-15 INTERIOR SURFACES of copper tube sections are illustrated above. Fig. 13, for Main Test Panel No. 1, handled sodium zeolite softened water exclusively. Fig. 14, for MTP No. 6, handled sodium zeolite softened water blended to 60 ppm. Fig. 15, for MTP No. 3A, conveyed sodium zeolite softened water blended to 110 ppm. Duration of test was 17 months

were obtained by subtracting the pointed micrometer measured pit depths from the nominal wall thicknesses of the various sized tubes. Similar results were obtained using the other methods to evaluate the average remaining wall thicknesses. The maximum loss of wall thickness was also determined, using measured wall thickness of new tube rather than nominal wall thickness.

The nature of corrosion of copper tubes using sodium zeolite softened water can be seen by examining Figs. 7 through 12. These are photographs of typical specimens which had not been acid cleaned. The effect of velocity on corrosion at constant temperature is shown in Figs. 7, 8, and 9 and of temperature at constant velocity in Figs. 10, 11, and 12. Visual examinations of the tube samples showed that, except for the clean and probably anodic areas, deposits covered most of the inner surfaces. The deposits were quite adherent and were harder when formed at the higher temperatures.

When observed in cross-section, the most severe pitting consisted of crescent or horseshoe-shaped formations, with the closed end of the crescent always in the same direction. The undercut portion of the pits always pointed upstream. This pitting was the result of erosion-corrosion, which is usually characterized by rapid and repeated destruction of the protective surface films.

The protective films are destroyed due to a relatively high velocity of the fluid medium, combined with turbulent conditions and the action of mechanically entrained air. The attack is combined erosion-corrosion; erosion removing the protective film or scale and subsequent corrosion of the exposed metal surfaces. Study of the acid cleaned portions of the 30 samples using all soft water indicated a

TABLE 4 — MAIN TEST PANEL No. 6, handling blend of sodium zeolite softened water and 60 ppm hardness water, revealed these observations under binocular-microscopic examination

Temperature, F	Tube diameter, in.	Observation of deposits and surfaces
50	⅛	Thin light tan deposit over dark film; scattered islands of light tan deposit, becoming less scattered at downstream end; some tube surface irregular at downstream end.
	½	Tan deposits covering most of surface area; some dark film visible on spots beneath deposits.
	¾	Tube surfaces covered with tan deposits (more than ½ in. section); some dark film again visible in spots.
	1	Same as ¾ in. section.
	1¼	Same as ¾ in. section; small pits in deposit scattered throughout tube; small strip in center of section (midway between ends) which looks like oily substance had covered deposit; three small areas devoid of deposit buildup; however, thin green-brown film is covering this area.
80	⅛	Surface covered with thin green-brown deposit; small islands of tan deposit scattered over surface; immediately down-stream of these islands, green-brown deposit is gone and dark film can be seen fading to deposit further downstream.
	½	Same surface deposit as ⅛ in.; again, there are islands scattered over surface, but these deposits are in an area where surface deposit is much lighter in color than the surrounding area; there is a small area where many islands have built up close together approximately 12 in. from exit end.
	¾	Surface covered with tan colored deposit; some scattered buildup of this deposit about 12 in. from exit end, becoming more frequent in last 4 in. of tube; islands are followed (downstream) by area where deposit is gone, showing a dark film.
	1	Rust brown deposit, somewhat flaky in appearance, covers most of surface; scattered patches of green-brown deposit can be seen where rust brown deposit has not formed; also, small patches of dark film are visible.
	1¼	Same as 1 in., with deposits ranging from green-brown to dark brown.
110	⅛	Surface covered with copper colored film; some scattered islands of brown deposit; some shallow pits visible over surface.
	½	Same as ⅛ in.
	¾	Surface deposit of light brown material; patches of copper deposits where metal is visible; bright metal usually accompanied by area of dark film on downstream side; a few small islands visible.
	1	Same deposit as ¾ in.; no bright metal visible; patches of dark film widely scattered over surface.
110	1¼	Surface speckled with combinations of green-brown and tan deposits and purple colored film; very small, widely scattered islands of tan deposit also visible.
140	⅛	Extensive attack over entire length of section; cathodic islands of brown deposit; copper colored film and shiny metal (anodic areas) make up surface of tube.
	½	Same as ⅛ in.; attack approximately as severe.
	¾	Same as ⅛ in.; attack not quite as severe; film is darker shade; less bright metal visible and usually adjacent to cathodic islands.
	1	Same color film as ¾ in.; small, thin areas of brighter film randomly placed over surface; no visible attack.
	1¼	Same as 1 in.; some small islands built up of brown deposit widely scattered over filmed surface.
170	⅛	Extensive attack; larger areas are covered with dark brown deposit; between deposits, copper colored film covers some areas while others are anodic areas as indicated by the shiny metal visible.
	½	Extensive attack; large areas are covered with dark brown deposit; between deposits, copper colored film covers some areas while others are anodic areas, as indicated by shiny metal visible.
	¾	Surface generally covered with a thin dark brown deposit; approximately 18 in. from exit end of section, wide band of dark copper colored film replaces deposit; same type of film appears further downstream as one more large area and smaller scattered areas.
	1	Surface speckled with various shades of brown deposit.
	1¼	Rust brown deposit covers surface; some very small islands of dark brown deposit beginning approximately 24 in. from exit end of tube; undercutting of deposits is visible; horseshoe shaped areas on upstream side of deposits have shiny film.
200	⅛	Extensive pitting; pits are shiny; other areas have green deposit; very few islands built up, but undercutting is visible on those islands that are present; some pits are aligned, forming chains up to 1 in. in length; green deposit covers more area at downstream end.
	½	Dark brown deposit covers entire area; no attack visible.
	¾	Same as ½ in.
	1	Same as ½ in.
	1¼	Same as ½ in., except deposit is almost black.

TABLE 5 — BOROSCOPE OBSERVATIONS of MTP No. 3A, made at final inspection after 17 months' operation, are listed below. Water was sodium zeolite softened, blended to 110 ppm hardness

Temperature, F	Tube diameter, in.	Comments
50	⅛	Thin greenish brown film.
	½	Same, with patches of dark brown deposits.
	¾	Same.
	1	Dark brown deposit over gray film.
	1¼	Dark brown deposit.
80	⅛, ½, ¾	Dark brown scale; no attack.
	1, 1¼	Dark brown film; no attack.
110	⅛	Bright surface; slight attack with horseshoe pits.
	½	Same.
	¾	Bright surface; no attack.
	1, 1¼	Greenish brown film.
140	⅛	Heavy dark brown scale.
	½	Same.
	¾	Same.
	1	Heavy reddish brown scale.
	1¼	Same.
170	⅛	Heavy brown film.
	½	Same.
	¾, 1, 1¼	Dark brown scale over reddish scale.
200	All	Heavy dark brown scale.

transition from a directional erosion-corrosion in the four test trains of the copper panel, MTP No. 1, operated at the four lower temperatures and higher velocities to an unusual "pin hole" type of pitting formed under the deposits in the test trains operated at low velocities and higher temperatures. These transitions were more marked in the larger diameter tube.

Apparently, for high temperatures there is less tendency for erosion-corrosion due to the effects of high velocities, although the corrosion product adhering to the walls is sufficiently porous to allow pitting. With larger diameter tubes, the velocities are lower and conditions are favorable for corrosion attack under the deposits.

The high temperature "pin hole" pitting effect is shown in the microscopical pictures of cleaned, corroded copper specimens in Figs. 13, 14, and 15. It is interesting that tremendous similarities exist between many of the failed corroded tubes removed

TABLE 6 — BINOCULAR-MICROSCOPIC observations of MTP No. 3A are listed below

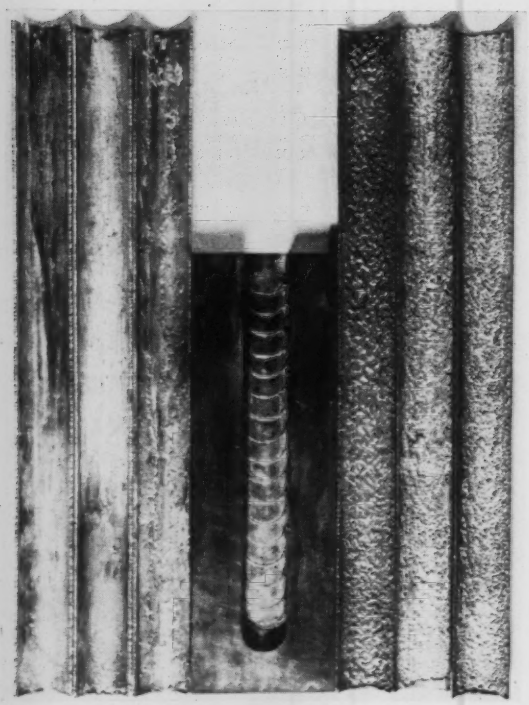
Temperature, F	Tube diameter, in.	Observation of deposits and surfaces
50	⅛	Generally covered with greenish brown deposit; surface is irregular with what seems to be large islands; small areas where deposit seems to have worn away reveal gray-brown film underneath; buildup of islands of brown deposit on exit end of tube; tube surface becomes more irregular (showing valleys) at this end.
	½	Surface spottily covered with greenish brown deposit mentioned above; areas where this deposit does not occur are covered with gray-brown film mentioned above; surface very irregular, showing many islands and pits covered with either deposit or film; top, greenish brown deposit seems to be "peeling" showing gray-brown film underneath.
	¾	Some deposit and film encountered; less area covered with thin greenish brown deposit; surface irregularities as mentioned in ⅛ and ½ in. samples are not evident; buildup of green-brown deposit is thicker as downstream end is approached; most islands have very pronounced *light green outline.*
	1	Surface almost entirely covered with very thin, flaky, brown deposit; some grey-brown film visible where other has flaked off; isolated pits scattered over surface in both areas; floors of pits are covered with light brown deposit; Some large film-covered areas appear "rough," i.e., like file.
	1¼	Entire surface covered with same brown, flaky deposit; where deposit has flaked off, film still appears; Surface irregularities not evident.
80	⅛	Surface covered with dark brown and gray-brown films running along axis of tube; first deposit buildup approximately 4 in. from downstream end; islands run across axis on thin band; surface downstream from this point is irregular; some deposits in this area seem to have broken off, exposing gray-brown film.
	½	Surface covered with film of varying shades of brown from reddish brown to olive drab; a few small, isolated deposit buildups were found and some thin, bright strips (not metallic bright) are evident along longitudinal axis.
	¼, 1, 1¼	Same flaky brown deposit over film as evidenced in previous samples; ¾ in. section has most area covered with film; 1 in. has most area covered with flaky brown deposit; 1¼ in. section has very small isolated areas where film is visible; deposit in this case is not very flaky.
110	⅛	Bright, copper colored film covering most of surface; some thin areas of brighter metallic finish running along length; surface smooth, except for small group of islands and pits near exit.
	½	Some general surface film; again, small group of islands on downstream end; immediately downstream from islands, bright metal can be seen indicating anodic area.
	¾	Same as ½ in., but islands cover larger area; anodic areas again evident downstream from some small deposits.
	1, 1¼	Brown deposit covering entire surface.
140	⅛	Surface covered with dark brown deposit; deposit appears to be porous.
	½	Deposit buildup more uneven than ⅜ in. section; brown film visible where there are no deposits.
	¾	Surface covered with brown deposit; extensive pitting has occurred along entire length of section, but on only one-half of surface; other half is completely covered with continuous deposit; some undercutting visible.
	1	General brown surface deposit; numerous small pits in deposit, getting larger and more numerous at downstream end.
	1¼	Some dark brown deposit, but with reddish brown deposit also forming; small pits occurring in deposit scattered over entire length; pits generally are smaller than those found in ¾ and 1 in. sections.
170	⅛	Dark brown deposit on surface appears somewhat porous; small isolated holes are visible in surface deposit; largest of these is approximately 1 in. from exit, metal surface can be seen below deposit; Surface seems to be pitted at this point.
	½	Surface covered with dark brown deposit; this deposit is more irregular in appearance than that on the ⅛ in. section, giving the appearance of islands; no holes visible in deposit.
	¾	Surface covered with dark and lighter brown deposit; surface of deposit very irregular, appears to be pitted to tube surface; deeper pits occur near downstream end, first isolated pits, then groups of pits; pits on upstream end are covered with black film, deeper pits through deposit and into tube surface are bright metal colored.
	1	Some dark brown deposit; some small pits in the deposit get larger at downstream end of tube.
	1¼	General dark brown deposit over black film; bright green deposit over brown very extensive at upstream end, thinning to nothing approximately 12 in. from exit; some light tan islands also at upstream end; small pits covered with green deposit, others with brown deposit, black film and copper colored film; pitting is not severe.
200	⅛	Entire surface covered with brittle dark brown deposit; deposit is not smooth, but there are no pits; in places where deposit has broken off from handling, thinner blackish brown deposit is visible.
	½	Same as ⅛ in., except deposit covering is in tact.
	¾	Same as ⅛ in.; most of deposit has broken off revealing light gray deposit over black film.
	1	Same as ¾ in.
	1¼	Thick deposit did not cover entire surface; 18 in. at center of section was not covered and has thin brown deposit covering; pitting (scattered) has occurred in this deposit; where heavy brown deposit has broken off, metal surface is covered by dark gray film.

from the campus distribution systems and tubes taken from the test panels.

Study Panels at Four-Month Intervals

The panels were run continuously except for interruptions at approximately four-month intervals when the trains were completely disassembled for inspection and studied by the corrosion committee of Copper and Brass Research Association. To avoid disturbing the deposits formed in the interior of the tubes, internal inspections were made with a boroscope. The final boroscope observations of the tube, made prior to cutting and sectioning, are summarized in Tables 1, 3, and 5. Table 2 gives the binocular-microscopic observations on the cleaned and uncleaned sample sections from the sodium zeolite panel. Heavy carbonate deposits were encountered in some of the samples taken from the 60 and 110 ppm blend water panels. The different physical conditions of these deposits and surfaces prior to cleaning are reported separately in Tables 4 and 6.

Measurements of remaining wall thicknesses were made by the pointed micrometer, dial micrometer, and radiographic methods, as described in last month's article. Comparison of the values recorded in Table 7 shows the close agreement of the methods. If equipment is available, the radiographic method can be the most rapid. "Step wedge" and typical chemically cleaned samples used for the radiograph-



16 COPPER STEP WEDGE and specimens for X-ray radiograph shown above

ic studies are illustrated in Figure 16. Note the close agreement of these three methods.

The effects of temperature on the amount of metal corroded away in terms of maximum loss of wall thickness are given in Figs. 1, 2, and 3. These maximum losses were obtained by subtracting the micrometer measured pit depths from the nominal wall thicknesses of the various sized tubes. These graphs indicate the critical nature of temperature on the corrosion of copper — even when sodium zeolite water is blended with hard water to produce some hardness in the test water.

It is noted by comparing these three figures that the increase of hardness to 110 ppm has made a marked reduction in corrosion above 140 F. However, the inner surfaces of the tubes are heavily covered with a scale deposit which would substantially reduce heat transfer and cause increased friction and pumping costs. It is interesting that, in the temperature range of 50 to 100 F, the corrosion rate due to the 110 ppm hardness water is greater than by the soft water.

Soft Water Very Aggressive Above 110 F

It can be concluded that the soft water used in this study is very aggressive above 110 F — particularly at high velocities. Further, increase of hardness apparently has the effect of increasing corrosion at lower temperatures. Blending to a 60 ppm hardness water has very little effect on corrosion up to 170 F. However, there appears to be a substantial reduction at the 200 F level. It is indicated that the corrosion rate of copper is markedly affected by temperature increase and is particularly high in the range of 130 to 170 F.

The effects of soft water and of blending hard water with soft water as related to increased velocities on the corrosion of copper tube can be analyzed by examining Figs. 4, 5, and 6. In a soft water system, such as tested, increased velocity appears to increase corrosion. The sharpest increase is at velocities in the neighborhood of 5 fps and at the highest temperature ranges. The effect of increase of velocity up to 13 fps on the corrosion of copper tube using soft water at a moderate water temperature is small. An increase of velocity above 4 fps promotes accelerated corrosion if the temperatures are above 110 degrees.

The use of water blended to 60 ppm hardness does not appear to alleviate the effects of velocity on accelerated corrosion, particularly in the higher

TABLE 7 — AFTER 17 MONTHS' OPERATION, copper tube from MTP No. 1 had these remaining wall thicknesses, in.

Tube diameter, in.	Tube nominal wall thickness, in.	Method of measurement	Temperature, F					
			50	80	110	140	170	200
⅜	0.035	Micrometer (dial)	0.030	0.029	0.025	0.020	0.012	0.015
		Micrometer (pointed)	0.033	0.031	0.027	0.021	0.014	0.016
		Radiographic	0.031	0.030	0.027	0.022	0.015	0.018
		Gravimetric	0.031	0.033	0.030	0.023	0.019	0.022
½	0.040	Micrometer (dial)	0.035	0.038	0.032	0.030	0.020	0.025
		Micrometer (pointed)	0.035	0.037	0.033	0.030	0.021	0.026
		Radiographic	0.034	0.037	0.032	0.030	0.020	0.031
		Gravimetric	0.036	0.038	0.032	0.032	0.027	0.032
¾	0.045	Micrometer (dial)	0.041	0.041	0.039	0.038	0.036	0.035
		Micrometer (pointed)	0.042	0.042	0.040	0.039	0.037	0.037
		Radiographic	0.042	0.043	0.039	0.040	0.038	0.041
		Gravimetric	0.042	0.044	0.040	0.038	0.038	0.040
1	0.050	Micrometer (dial)	0.048	0.045	0.046	0.043	0.044	0.047
		Micrometer (pointed)	0.047	0.044	0.040	0.043	0.044	0.047
		Radiographic	0.046	0.045	0.047	0.046	0.046	0.049
		Gravimetric	0.047	0.048	0.046	0.044	0.044	0.047
1¼	0.055	Micrometer (dial)	0.054	0.054	0.052	0.053	0.053	0.053
		Micrometer (pointed)	0.053	0.054	0.050	0.053	0.052	0.053
		Radiographic	0.054	0.053	0.050	0.052	0.053	0.053
		Gravimetric	0.053	0.054	0.053	0.053	0.052	0.053

temperature ranges. The overall corrosion, however, is slightly reduced by blending. Increasing the hardness to 110 ppm substantially reduces the corrosion tendencies due to increased velocities. However, it should also be noted that, as the temperature increases, there is a marked increase in deposit build-up above 110 F.

This set of tests indicates that the corrosion of copper by sodium zeolite water containing oxygen and carbon dioxide is not substantially reduced by blending to 60 ppm and that corrosion is reduced at high temperatures by using 110 ppm water, but at the cost of laying down a heavy carbonate scale above 120 F. Even with the heavy scale, some corrosion occurs.

Total corrosion appears to be the net result of temperature and velocity as well as the degree of softening or blending. Increasing hardness in the system has the tendency to reduce the erosion-corrosion effect of soft water on copper tube. Copper was found to be relatively adversely affected by sodium zeolite softened water or sodium zeolite softened water blended with hard water at high temperatures and high velocities. ∓

SAMUEL R. LEWIS, consulting mechanical engineer and a member of Heating, Piping & Air Conditioning's board of consulting and contribution editors, comments informally on practical problems in the field.

Sam Lewis says:

"Use of the Term 'Square Foot' As a Measure of Heat Should Have Been Outlawed Long Ago"

RECENTLY, I had occasion to design a new steam heating system for a large building, the plans for which were drawn-up some 30 years ago. Since that time the engineering profession has tried to divert itself from the use of the term *square foot* as applied to the ability of a piece of equipment to transmit heat to air.

Originally, it may have been the unit of measure for the heat loss necessary to condense a few pounds of steam from its gaseous state to its liquid state. Or, it may have been a measure of the amount of fuel that could be burned at some vaguely understood efficiency in a boiler. In either case, use of that term as a measure of heat was abandoned long ago and, in fact, should have been outlawed.

The old plans for the building show rectangular marks against the walls opposite many of the windows. One of these carries the notation, "14 sections, six tubes, 23 in. high, 27 sq ft."

In order to make new plans comparable with the designs for the original plant, I interpreted this notation to present language: "radiator 9 in. wide and 23 in. high, 6.75 MBtuh."

By adding all the square feet marked on the old plan, I found that the boiler was supposed to keep busy all of 5000 sq ft of surface in the cast iron radiators, including the pipes that connected the square feet to the boiler.

No one knows whether the square feet of surface mentioned was prime, with steam on the side of the metal exposed to the air, or whether the square feet were gills and flanges, with air on both sides and with steam to warm only one edge of each gill that touched the tube holding the steam.

One of the problems was deciding whether the old square foot heat transmitters were connected to each other, not only at the bottom, as was required for steam, but also at the top, as is necessary if the system is ever converted to operate with hot water.

The inspector of an old square footer must find out whether it can be expected to work with water instead of with steam.

I have looked through hundreds of advertisements of many manufacturers. Apparently no one hopes to sell a thermally-circulating air heater such as the old square footer of sections and tubes. The foundries that used to cast them around pre-dried sand cores must have progressed to fabrication of these elements from sheet metal. ∓

New Metal Working Plant Features Argon-Pressurized Pure Atmosphere

Inert gas facility permits fabrication of important products for the space age

FACILITIES for providing atmospheric purity is one of the main features of the newly completed plant built by the Universal-Cyclops Steel Corp. at Bridgeville, Pa., for the U.S. Navy Bureau of Aeronautics. Super high temperature refractory and reactive metals and alloys such as molybdenum, tungsten, columbium, and tantalum are being produced in this plant for fabrication into products for space vehicles, missile nose cones, and rocket engines.

When these metals are heated to the temperatures necessary for fabrication (between 3000 and 5000 F), they instantly react to the earth's atmosphere. If these metals can be processed in an atmosphere of 99.995 percent pure argon, then oxidation and nitridation is prevented.

To achieve this objective, an inert atmosphere pilot fabrication plant, 40 × 80 × 22 ft and composed of 3/16 in. welded steel sheets, has been erected

INTERIOR VIEW of In-Fab facility shows ductwork, floor grilles necessary for handling argon in sealed plant. Metal fabrication plant, enclosed in a larger structure, is filled with inert argon gas to work on exotic metals for use as missile nose cones, rocket and jet engines, and space vehicles. High cost of argon made gastightness imperative.

WORKER in "space suit" closes inside door of one of the entry locks that keeps argon gas from escaping. Fabrication of such metals as columbium, tantalum, molybdenum and tungsten—which instantly react to the earth's atmosphere at the high temperatures needed for successful fabrication (3000 F to 5000 F)—will be processed, then coated to prevent oxidation and nitridation before being exposed to the outside world

within a larger building that houses some external facilities.

The technicians operating this equipment wear "space suits." Each man carries his own oxygen supply, CO_2 adsorber, sump bottle for vapors, and self-contained air conditioning system complete with small blower for circulation. Power and telephone lines are plugged into wall outlets.

The major difficulties in building this "first time in history" facility were:

1) Providing optimum safety for technicians working in the no-oxygen atmosphere

2) Keeping the expensive argon gas from leaking out of the inert fabrication plant

3) Maintaining atmospheric purity, despite frequent opening and closing of the three personnel locks, one equipment lock, and a material lock.

Local Hot Spots a Problem

One of the problems that had to be solved in the design of this plant was local hot spots caused by the billets heated to 4000 F. This was especially a problem at the impactor and the rolling mill when the billets were worked hot. The heat generated at the rolling mill is carried off by the room cooling system which circulates 62,000 cfm of argon over water cooled coils. Scrap from the shear is cooled when it drops into water-cooled boxes. At the impactor pit, additional cooling is provided in the scrap and furnace pit by having double-steel plate walls with water circulating between the walls. Also, plate coils are placed at strategic locations to provide a barrier against direct exposure to the heat source. Both machines are operated remotely from outside the room. Heat absorbing glass is used in the operators' observation windows. Fans circulate argon over the windows to improve conditions for the operator.

Special polished stainless steel reflective frames are installed around the periphery of the windows to prevent overheating and hardening of the seal gaskets on the windows. Silicone high temperature rubber is specified throughout for these gaskets and o-rings.

A unique cooling arrangement is used in the induction heating furnaces, where the copper cooling water coils double as high frequency induction coils for heating the furnace.

Aluminized reflective smocks or coveralls are worn by workers inside the room to reduce the radiant heat load on the suit cooling system and to protect the suit material itself from overheating.

Maintain Close Argon Pressure Balance

Another problem encountered was the change in volume of the argon within the room due to temperature and atmospheric pressure changes. A posi-

tive pressure of ½ oz per sq in. is maintained within the room to prevent infiltration of air and other impurities. A duplex pressure controller maintains the pressure by bleeding excess argon, caused by increasing room temperature from the 100 psig argon compressor discharge to a 2000 cu ft storage tank. The argon compressor, which supplies 100 psig argon to operate the impactor, takes suction from the room so argon removed from this system actually is removed from the room.

When the room temperature subsides, the other part of the duplex controller operates another control valve to bleed argon from the storage tank to the room. If the storage tank pressure drops below 20 psig, makeup argon is fed to the tank from high pressure storage cylinders.

A vacuum-vent relief valve set at 0.5 psig pressure and vacuum protects the room from over- or underpressure in the event the pressure balance system should fail.

The above type of "*breathing*" action would occur in the room each time a billet is heated and worked or whenever there is a change in the barometric pressure outside the room.

Minimize Level of Impurities

Another problem was the high purity requirements of the argon inside the room. It was established that the argon would be limited to a maximum impurity level of 255 ppm, made up of 150 ppm of nitrogen, 50 ppm of oxygen, 50 ppm of water vapor, and 5 ppm of hydrocarbons. Argon returned from the purification plant will have a maximum of 50 ppm total impurities, of which no more than 5 ppm will be oxygen.

The argon purification plant, which cost approximately $500,000, operates by removing the oxygen by combining it with hydrogen to form water in a catalytic reactor. The argon is then dried, liquefied, and passed to a bubble cap tower for nitrogen separation. A high pressure nitrogen refrigeration system supplies additional cooling for the liquefaction and separation process. The nitrogen impurity stream is discharged to the atmosphere.

The relatively high cost of argon (6 cents to 10 cents per standard cu ft) presented several other problems. One of these is the necessity of having a gastight enclosure to minimize argon losses. All items of equipment have a seal plate between the baseplate and the foundation. Anchor bolts are seal welded to the plates where they pass through. The equipment is then grouted under this plate.

The room encloses a space of approximately 65,000 cu ft. This represents an initial argon charge cost of about $3900 to $6500. So that this gas would not be wasted, it was decided to remove the argon through the purification plant to storage during shutdown periods.

Removal is carried out by bleeding nitrogen into the room at the top purge duct system and removing the heavier argon at the bottom of the room. This is done at a rate of about 7200 cfh to try to maintain a nitrogen-argon interface and purge by displacement. This reduces the impurity load on the purification plant.

After the argon is removed, the nitrogen is displaced by air and people can enter the room to work.

Reverse Procedure When Readmitting Argon

When the plant is put back in operation, the air is first displaced by introducing nitrogen at the top and removing air to atmosphere at the bottom. Nitrogen is added because it is easier to remove from the argon than oxygen. The argon is then introduced at the bottom and nitrogen is displaced at the top until argon appears in the atmospheric discharge. The purification plant is then started and the room brought up to the required purity.

In general, lighter gases are brought in at the top and heavier gases at the bottom to take advantage of the difference in density.

Under normal operation, impure argon is removed through a duct system spread over the ceiling of the room since this is where the lighter impurities would collect. The pure argon is introduced through a distribution system at the points where the hot metals are worked to insure the highest purity in that area.

Entrance of men, materials, and equipment is made through a system of double-door locks to control leakage. Personnel normally enter and exit through a man lock. These locks have sliding doors which are sealed with an inflatable rubber gasket around the periphery of the door. Any air which enters from the outside is purged from the lock by means of a nitrogen purge system. This is controlled by a cycle timer which then allows the inner door to be opened. The doors are interlocked so only one door can be opened at a time, except in cases of emergency when this interlock can be bypassed.

Two crash doors are strategically located for emergency exit of personnel in the room. Interlocking is required on these doors, but purging is not.

Materials and equipment are passed through locks which are evacuated with vacuum pumps to eliminate air on entering and conserve argon on leaving.

The prime subcontractor of this unique facility was The Howard P. Foley Co. Engineering consultant was the Tampa Bay Engineering Co. Subcontractor for the argon purification plant was Air Products, Inc. The engineering and design was performed by the Rust Engineering Co., which also provided architectural supervision during construction. ∓

Will Solar Energy Be the Heat Source For Tomorrow's Heat Pump?

An investigation has been made at the University of Kentucky, in which the solar energy incident on a solar collector has been used as a heat pump source to supplement that stored in the earth's crust. A collector and ground coil supplied the evaporator load during the heating period and the soil adjacent to the ground coil served as a reservoir for temporarily storing excess solar energy accumulated during bright sunny days. Due to the unpredictable nature of solar radiation and the lack of knowledge of the variation of the physical properties of the soil, calculations were based on monthly average values. A relative cost of operation of the system is also included. Actual operation of the heat pump system is limited to the assumptions made and to the capability of the machine to follow heating load fluctuations.

Solar Energy: Heat Source for Tomorrow's Heat Pump?

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SOLAR ENERGY, the one income energy that is abundantly available everywhere except in the polar regions, has great potential for use with the heat pump. This energy can be either in the form of direct radiation or as energy stored in the earth's crust.

The water source heat pump has certain limitations, in general, due to the absence of cheap, pure, inexhaustible water supplies in most localities. Likewise, an air source heat pump is limited in that it must deliver its maximum heating capacity when the outdoor temperature is the lowest, a condition which adversely affects its performance.

Therefore it is apparent that solar energy, as a heat source for heat pump applications, needs additional attention.

HERE'S WHAT THE TESTS SHOW

On the basis of the assumptions made in arriving at the performance of the solar-earth heat pump, the following conclusions are made:

1) When solar energy is used for space heating, the most desirable location for places north of Lexington, Ky., seems to be a south vertical surface. The reduction in solar intensity on this surface, due to large angle of incidence during early and late heating season, is in accordance with the heat demand of the building.

2) A comparatively large collector area, unrestricted by shade of neighboring trees or houses, is required. This necessitates a large building site.

3) Solar energy received on a south vertical surface and other orientations of the collector has to be recorded in order to correlate the nature of variation of the diffuse solar radiation and the method of conversion of horizontal insolation to that for the required orientation.

4) Solar collector efficiency calculations indicate that the major reduction in useful collection of solar energy is attributed to the transmittance and reflection losses due to the presence of glass cover plates. Optimum number of collector plates can be determined by field investigation. It is possible that a single cover plate might improve the collector efficiency when used on the evaporator side of the heat pump.

5) The irregular nature of solar radiation necessitates the use of a sufficient length of ground pipe to cope with the heat demand during cold cloudy weather. Thus the area of the solar collector does not influence the length of the ground pipe, although its use will permit savings in operating cost.

6) Power requirement of the circulating pump determines the diameter of the ground pipe. The length of the ground pipe depends on the physical properties of the soil which vary throughout the year. A reasonable strength of heat source should be assumed in order to avoid low evaporator temperatures when the atmospheric temperature is very low, which tends to improve the heat pump performance temporarily.

7) An increase in collector area reduces the operating cost and the load on the ground coil under average conditions. However, the cost of the collector will limit its size.

8) Capacity modulation of the compressor and blower are necessary for the heat pump to meet the variation in the building heat load.

9) Space heating with a solar-earth heat pump at 1.5 cents per kwhr, with collector surface of 400 sq ft, costs less than heating with gas at 76.8 cents per thousand cu ft; operating cost at 1.6 cents per kwhr is slightly greater than heating with gas.

10) The present paper gives information concerning the merits of solar-earth heat pumps for space heating. It is hoped that in the near future considerable attention will be given to the development of a heat pump system of the proposed type. The basic data thus obtained will lay the foundation for better and more economical designs. It is apparent that the virtually inexhaustible supply of the sun's energy should be utilized to maximum advantage either directly or indirectly.

The earth, due to its inherent poor thermal properties, can supply large quantities of heat only at the expense of low evaporator temperature, thereby lowering the performance of the heat pump. This poor performance can be partly augmented by increasing the buried length of the ground coil, which in turn increases the installation cost.

For a good many years to come, progress in the use of solar energy as capital energy will be limited since its yield per unit area is low. However, during the present decade, considerable interest has been shown in using solar energy for space heating. Experimental work done in several localities in the United States has shown varied degrees of success. Direct use of solar radiation for space heating is impracticable since its availability is limited to cloudless days and its nature of variation is unpredictable.

Use of the ground coil and solar collector as sources for heat pumps is worth investigating[1]. On bright sunny days the earth provides storage space for solar energy collected in excess of that needed for heating requirements. This energy will be readily available during nights and cloudy days when there will be either no radiation or insufficient radiation from the sun. Thus the combination of solar collector and ground coil properly fills the role of an energy surge reservoir.

The intermittent operation of the ground coil improves the performance of the heat pump system. During summer months, when the system operates on the cooling cycle, the earth is a relatively poor heat sink due to the fact that moisture migrates away from the ground coil and the soil may not cling so tightly to the pipe. With a suitable modification of the solar collector, it can be effectively used as an air coil, thus making the system function as a combined air-earth heat pump during the cooling cycle.

This article is the result of extensive calculations that were made to determine the performance of a heat pump system using a ground coil and a solar collector as heat sources[2]. It is an attempt to show the economic feasibility of such a combination over a heat pump system operating with a ground coil alone as a heat source. The results have been compared with conventional heating units. Available sources of technical data have been used to formulate design criteria and performance characteristics of the proposed system. The irregular nature of solar radiation and the lack of knowledge of the variation of the physical properties of the soil have limited the calculations to monthly average values.

Estimate Heating Load from Weather Data

The structure selected for sizing the heat pump system and obtaining its performance characteristics is located at 38 deg north latitude where the general climatic characteristic is of continental type with a broad daily temperature range. Mean dry bulb temperatures for winter, spring, summer, and fall quarters are 34.4 F, 53.6 F, 74.6 F, and 57.2 F, respectively.

On the average, there are 23 days a year when the maximum temperature is 90 F or higher and 21 days with a maximum of 32 F or lower. The minimum temperature is 32 F or lower, on an average, during 90 days a year and below zero during two days. Mean annual precipitation is 42.82 in. and the spread is fairly uniform during all four quarters. Snowfall averages 19.1 in. and the ground water temperature is 57 F.

The heating load of the building is estimated as 46,700 Btu per hr for an inside dry bulb temperature of 70 F, outside dry bulb of zero F, and a wind speed of 12 mph. Estimation of the cooling load was not made since the size of the equipment for heating is larger than the cooling requirements in central and northern areas in the U. S. A.

Solar energy records for winter months (data taken at the University of Kentucky) reveal that the days having highest daily average temperature experience lowest solar radiation, and vice versa. This is attributed to cloudiness. For example, on Feb. 12, 1955, the average outdoor temperature was 6 F and the total radiation on a horizontal surface was 1759.2 Btu per sq ft per day. The corresponding figures for January 4, 1955 are 56 F and 133.7 Btu per sq ft per day, respectively. Since heat losses of the building are also high on cold days, the nature of the variation favors the use of a solar collector.

• How solar collector is designed

The optimum south vertical tilt for fixed collectors located in the northern hemisphere is latitude plus 23.5 deg. Sunshine falls on such collectors from dawn to dusk and the incidence will be normal at midday on the winter solstice. For Lexington, Ky., this tilt is 61.5 deg, which is very steep. Moreover, such collectors will present problems of dust collection and elaborate shading during summer.

The next best location for cities north of Lexington is a south vertical surface, where a collector will receive additional radiation due to reflection on bright snowy days. Dust collection is minimum and the problem of shading in summer is reduced due to

an unfavorable angle of incidence of the radiation from the sun.

Solar radiation data available for most U.S. cities is given for horizontal surfaces due to the ease of mounting the instruments and the minimum of orientation problems associated with them. Conversion of this energy to any other location of collector cannot be determined by the methods of spherical trigonometry alone, since the nature of diffuse radiation for the locality is not known.

Here, the available solar energy per square foot of collector was obtained by following the method given by E. M. Brooks in a symposium on space heating with solar energy[3]. He suggests the use of a single conversion factor for converting average monthly horizontal total radiation to that corresponding to the required orientation of the collector. The factor is calculated for the middle day of the month and ± 2.5 hours from solar noon, and is based on spherical trigonometric methods. This is then corrected for diffuse radiation and cloudiness. Brooks claims that the results obtained from such an equation check the Blue Hill Observatory data within ± 5 percent. In the absence of observed solar energy falling on a vertical surface, suitable data was calculated by adapting the above procedure.

The material of the collector is aluminum in which the top surface is painted black to increase the absorptivity coefficient. The determination of optimum number of glass covers requires a careful analysis of heat transmission and losses. Since bright cold days are common, it is suggested that two glass covers may be appropriate.

Convection and radiation losses from the surface of the collector are calculated by the method suggested by H. C. Hottel and B. B. Woertz[4]. The rear of the collector is well insulated to reduce heat losses to a low value. Sides of the collector box are painted white so that most of the incident solar energy may be reflected onto the collector.

Determine Net Radiation Absorbed

The net solar radiation absorbed by the fluid flowing through the collector pipes can be obtained by accounting for transmission, collector, and heat capacity losses. The heat capacity loss of a collector is defined as the mean heat capacity of the fluid measured above the outside air temperature each time the collector stops operating. Due to the uneven temperature distribution across any two parallel pipes, there is a slight reduction in absorption of heat which may be best described as "fin efficiency."

In a poorly designed collector this may be of considerable importance. For example, assuming a combined overall coefficient of heat transfer of 0.534 Btu per hr per sq ft per F for glass covers in the front and insulation in the rear of the collector, and taking the thermal conductivity of aluminum as 123 Btu per hr per ft per F, the fin efficiency for a 16 gage sheet with 12 in. tube spacing is 0.932. The fin efficiencies for a 24 gage sheet with 6 in. and 12 in. tube spacings are 0.961 and 0.848, respectively.

In the collector designed, 16 gage aluminum sheet with 6 in. tube spacing was adopted, for which the fin efficiency is 0.984. The performance of this collector is based on monthly average values. A summary of results is listed in Table 1 and the following remarks give information on these data:

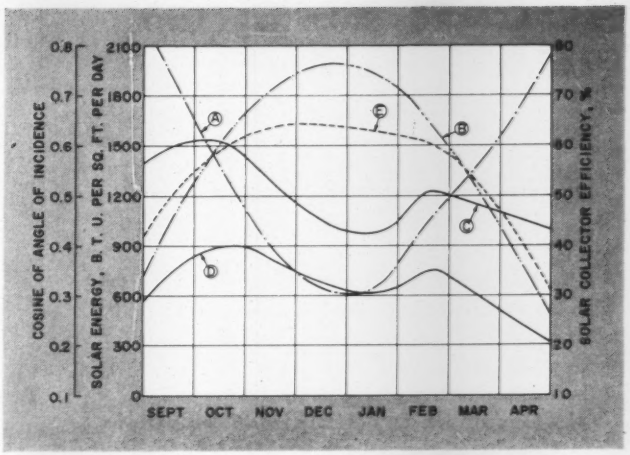
1) The local climatological data are average values for 30 years (1921 to 1951), and were obtained from data recorded at the Blue Grass Airport, Lexington.

2) The mean horizontal insolation are the monthly averages of the daily values taken and recorded at the University of Kentucky over a period of five years. Maximum and minimum values are corresponding average values for the months in the table.

3) Correction factor γ converts monthly horizontal insolation to south vertical orientation. It is based on

TABLE 1—CALCULATED PERFORMANCE data of a solar collector from September through April is listed here

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Mean daily dry bulb temperature, F	68.9	57.3	43.8	34.9	32.5	34.5	42.4	52.9
Mean maximum temperature, F	80.2	68.5	53.1	42.9	40.5	42.7	51.8	63.0
Mean minimum temperature, F	57.6	46.1	34.5	26.9	24.5	26.3	33.0	42.8
Mean daytime temperature, F	72.3	60.7	46.6	37.3	34.9	36.9	45.2	55.9
Mean horizontal insolation, Btu per sq ft per day	1934	1363	884	638	628	1002	1346	1783
Maximum horizontal insolation, Btu per sq ft per day	2526	2054	1530	1196	1325	1841	2406	2828
Minimum horizontal insolation, Btu per sq ft per day	661	237	119	105	86	142	265	295
γ, conversion factor, deg	34.00	48.58	60.75	66.67	64.25	54.75	40.83	25.42
Cosine of angle of incidence	0.4441	0.5986	0.7124	0.7614	0.7417	0.6595	0.5190	0.3493
Mean south vertical insolation, Btu per sq ft per day	1484	1523	1290	1041	964	1208	1143	1043
Collector operation, hours per day	12	10	9	9	9	10	11	12
Collector losses, Btu per sq ft per day	73.9	59.5	50.2	48.5	48.1	53.8	61.0	69.4
Heat power absorbed by fluid, Btu per sq ft per day	727.3	899.7	821.4	667.4	608.0	735.4	607.4	408.7
Collector efficiency, percent	49.0	59.1	63.7	64.1	63.1	60.9	53.1	39.2



1 PERFORMANCE of a south vertical collector when solar-earth heat pump operates as space heater. Curves are identified as follows:

A—Solar energy incident on horizontal plane, i.e., as measured by pyrheliometer at University of Kentucky

B—Cosine of angle of incidence

C—Solar energy incident on heat pump collector

D—Solar energy absorbed by transport fluid

E—Efficiency of solar collector

± 2.5 hours from solar noon for the middle day of each month after correcting for diffuse radiation and cloudiness.

4) Mean south vertical insolation were calculated from the equation:

$$I_V = I_H \tan\gamma$$

where I_V and I_H are south vertical and horizontal solar insolation, respectively.

5) The number of hours of collector operation is the same as the number of sunshine hours (to the nearest hour) per day. These are calculated for the 15th day of every month and represent an average value for the entire month.

6) Heat power absorbed by the fluid is the energy available after accounting for all losses.

Some of the data listed in Table 1 is presented graphically in Fig. 1. The deviation between curves *A* and *C* is due to the angle of incidence effect of diffuse radiation and cloudiness. Daily average solar radiation incident on a south vertical collector during the heating season is lowest in January due to shorter length of winter days even though the angle of incidence is favorable.

The energy received during September and April is low, due to unfavorable angle of incidence. Energy absorbed by the transport fluid follows a pattern similar to curve *C*. As expected, the *overall collector efficiency** has the highest value for the month of December. This is due to the most favorable angle of incidence. Note that the effect of unfavorable angle of incidence is threefold: (1) it reduces the itensity of normal radiation over the collector; (2) increases the transmissivity losses; and (3) reduces the effective area of the collector since the sides of the collector cast a larger shadow on the plate.

• Designing the ground coil

The capacity of a ground coil to absorb or reject heat depends on the characteristics of the soil in which the coil is buried. The problem has been approached from a theoretical standpoint, based on the principles of heat conduction by L. R. Ingersoll and H. J. Plass[5], Ingersoll, et al[6], and E. B. Penrod[7]. These have been supplemented by experimental work of C. H. Coogan[8] and G. S. Smith[9]. The following is a summary of published results which dictates design criteria for a ground coil:

• Types of heat exchangers:

a) On the basis of rate of heat absorption per unit area, planar heat exchangers and spherical cavity heat exchangers are inferior to isolated line heat sources.

b) Similarly, flat grid, star grid, helix, and tubes having fins or any other form which provides a large surface area but has a small enclosed volume of earth, are inferior to one with the same area stretched out in the form of a long pipe. This means that, on the basis of equal area, a long pipe with a small diameter is more efficient than a short pipe with a large diameter.

c) Hairpin loops or pipes placed in close proximity are inferior to well-separated pipes. However, if the duration of operation is small, the performance of such arrangements are comparable.

• Properties that influence the time rate of heat absorption through a ground coil:

* *Overall collector efficiency* is the ratio obtained by dividing the heat power absorbed by the normal incident energy on the collector for a given orientation.

a) The rate of heat absorption is affected by the duration of operation. When the coil is operated steadily, the rate of heat absorption decreases as time increases since the temperature gradient decreases. This is true for all temperatures.

b) The rate of heat absorption is affected by the value of the thermal properties and density of the soil. Solutions to heat conduction problems based on constant thermal properties indicate that the value of thermal conductivity is very important.

c) Composition and orientation of soil particles affect the value of thermal conductivity[10].

d) For a given dry density, denser soil holds more moisture which improves heat transfer rates. During winter, the pipe is at a lower temperature which induces moisture migration toward the coil.

e) During winter operation, freezing of moisture around the pipe will retard cooling of the ground pipe by about 10 percent which, in turn, improves the coil efficiency slightly.

f) The temperature drop across the pipe wall is generally proportional to the rate of heat absorption. In case of surface temperature variation, there will be added soil temperature variation in the proximity of the pipe. However, the drop in temperature due to pipe alone is a function of the absorption rate.

• Lack of knowledge of thermal properties and other factors which influence heat transfer rates:

a) The nature of variations of thermal properties of soils forbids the treatment of soil as a homogeneous material and using a single value of thermal conductivity.

b) With present techniques, it is impossible to ascertain the rate of moisture migration from a warmer to a colder region.

c) Underground water movement alters the value of heat transfer rates as obtained on a pure heat conduction basis. The rate of formation of ice near the pipe has similar effects.

d) Periodic temperature variation of the soil is difficult to ascertain. However, due to time lag and damping effect, this is not a serious factor at great depths.

e) Poor adhesion of soil to the surface of the ground pipe affects the heat transfer rates. This effect is serious during summer operation when moisture migrates away from the soil, leaving voids and air spaces that are inferior heat conductors.

• Simplifying assumptions in the design of a ground coil:

a) The temperature variation of the soil can be assumed to be sinusoidal.

b) Constant values of thermal properties which are representative for the soil can be used without losing too much accuracy. These data can be obtained by simple laboratory tests.

c) For circular isolated tubes, since the rate of heat absorption is very nearly independent of diameter, the criterion for determining the diameter of the pipe is based on friction losses due to the flow of the transport fluid.

d) The length of the coil should be of such value that it is capable of supplying the evaporator load at design conditions without lowering the evaporator temperature excessively.

Test Job Needs 950 Ft of Ground Pipe

The soil in which the ground coil is buried falls under the general Casagrande classification of lean clay and has a thermal conductivity and specific heat of 0.84 Btu per hr per ft per F and 0.37 Btu per lb per F, respectively. Density and moisture content are 120 lb per cu ft and 16 percent. The mean temperature is about 58.5 F, with a surface amplitude of nearly 24.5 F.

At a depth of 5 ft, the amplitude is 12.35 F, with a time lag of 40 days. Average values of the strength of the heat source and heat sink for the ground coil used in the present investigation are 18 Btu per hr per ft and 15 Btu per hr per ft, respectively. The presence of the solar collector raises the average evaporator temperature which improves the performance of the system. This has the effect of increasing the evaporator load which in turn raises the strength of the heat source†.

Based on the above indicated data, the length of the ground pipe was estimated at 950 ft for heating the structure with a design load of 46,700 Btu per hr at zero F DB outside[7]. Since the rate of heat absorption is independent of the flow circuit, the ground coil can be connected in parallel with the collector to minimize friction losses. This also reduces the inlet-outlet temperature difference.

Based on the estimate of solar energy recoverable, a 400 sq ft collector would be adequate. However, the effect of altering the collector area on the performance of the unit is included in this discussion.

During daytime, when solar energy is collected, the air temperature is higher than the average based on 24 hours. The effect is to reduce heat losses during sunshine hours. Due weight to this fact is necessary to account properly for the net solar radiation available for storage. To determine collector losses, H. C. Hottel and B. B. Woertz[4] suggest the use of the equation:

† Solar effect is considered as bulk energy added to the evaporator raising its temperature. In the above statement, the higher heat source in the presence of the collector is equivalent to having another coil of the same proportion without a solar collector, but having a larger strength of the heat source. The net increase in heat output is just equal to the solar energy collected.

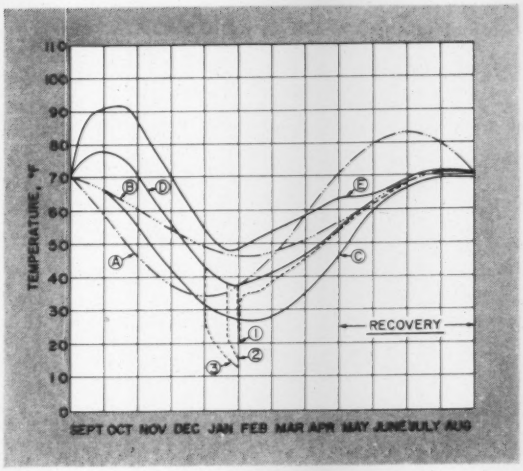
$$t_o = 0.7\ t_{mean} + 0.3\ t_{max}$$

where t_o is the mean monthly daytime temperature, t_{mean} is the mean normal temperature, and t_{max} is the normal daily maximum temperature.

In this paper the same equation is used for calculating collector losses. To be consistent it is necessary to use it to determine the building heat losses during sunshine hours. Also, its advantage over the degree-day method may be explained as follows: Degree days, as listed with climatological data, are based on 65 F, which means 5 F are allowed as solar effect for the entire heating season. In September and April, it is quite probable that on days with the outside temperature at 65 F, heating of a building may not be necessary. During colder months the solar effect may not be sufficient to raise the daytime outdoor temperature by 5 F. Use of this empirical equation gives the daytime temperature slightly higher than the mean.

Table 1 indicates that the difference between t_o and t_{mean} varies from 3.4 F to 2.4 F — being lowest during the coldest months. This slight difference reduces the building heat loss, but it is from 3 to 5 percent higher than that obtained by the degree-day method. Moreover, t_{max} for a particular month is influenced by the number of sunshine hours and the atmospheric conditions of the locality. Hence, for accurate engineering analysis this procedure is preferred over the degree-day method. Heat loss at any particular temperature is obtained by multiplying the design loss by the ratio of the actual temperature difference to that at design conditions, namely, 70 F.

The evaporator side of the heat pump obtains its energy both from the collector and ground coil, and the equilibrium of such a solar-earth heat pump system is determined by the amount of heat absorbed in the evaporator. A high temperature evaporator source improves the performance of the heat pump, which in turn reduces the cost of operation. Thus, by the use of a solar collector, an earth heat pump has a higher *HER** (heating energy ratio) on a seasonal basis. Since the *HER* is known, the average evaporator load can be calculated by the use of the equation:



2 COMPARATIVE STUDY of effect of using a solar collector in conjunction with a ground coil yielded these results. Curves are:

A—Undisturbed temperature of earth's surface

B—Undisturbed soil temperature at a depth of 5 ft. Disturbed soil temperature at the surface of the ground pipe for average conditions

C—Operating with ground coil only

D—Operating with ground coil and collector having 400 sq ft of surface

E—Operating with ground coil and collector having 800 sq ft of surface

Disturbed soil temperature at surface of ground pipe for design conditions:

1—One day

2—Ten days

3—One month

$$q_e = q\ (HER - 1)/HER$$

where q_e is the evaporator load in Btu per hr and q is the average rate of building heat loss in Btu per hr. From this equation it is apparent that the evaporator load is greater for a heat pump system with a higher *HER* which is accomplished by having a solar collector. This increases the strength of the heat source with a fixed length of ground pipe, which is exactly the effect of having a solar collector. A reasonable value for the strength of the heat source is 20 Btu per hr per ft for the type of soil considered.

• Performance of Ground Coil, Solar Collector

In the absence of experimental data, the undisturbed soil temperature and the disturbed soil temperature at the pipe surface can be estimated to a fair degree of accuracy by following the theory proposed by L. R. Ingersoll and H. J. Plass.[5] A comparative study of the effect of using a solar collector in combination with a ground coil is shown in Fig. 2, which includes the assumed undisturbed soil temperature at the surface and that at a depth of 5 ft.

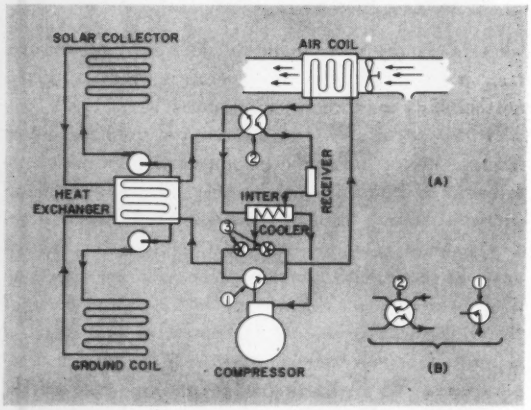
The disturbed soil temperature in each case is obtained by treating the evaporator load as causing a

*HER is the ratio obtained by dividing the heat energy delivered by the heat pump by the heat equivalent of the work supplied. Similarly, *CER* is the ratio obtained by dividing the refrigeration effect produced by the heat pump by the heat equivalent of the work supplied.

disturbance, and calculating the coil surface temperature by a method described by E. B. Penrod[7]. If the solar energy collected is in excess of the evaporator load requirement, the earth acts as a heat sink and stores the surplus solar energy. The net effect is to increase the surface temperature of the coil as well as the temperature of the soil adjacent to it.

Fig. 2 also includes the effect of long periods of no sunshine on soil temperatures. The dotted portions of the figure are obtained by assuming that the heat pump is supplying the design load when the net solar gain during this period is zero. These calculations are made by treating the excess load over and above the average evaporator load as additional disturbance and evaluating the temperature of the coil surface. The shapes of the curves indicate that the effect is prominent in the initial part of such a period. The recovery temperature curve is obtained by assuming the net excess load above average evaporator load as zero. The peculiar shape of the curve is consistent with poor thermal properties of the soil. Additional calculations showed that, under long periods of no sunshine, the lowest temperature attained is almost the same in all combinations chosen.

A preliminary calculation showed that a heat pump with 760 sq ft of collector surface and an auxiliary storage system is just sufficient to heat the building during January, the peak month. The disturbed soil temperature curve with 800 sq ft of collector surface lies above the undisturbed soil temperature at a depth of 5 ft, which corroborates the fact stated above. A collector having 400 sq ft of surface was chosen for the system under consideration.



3 FLOW DIAGRAM of proposed heat pump system shown above:
A—Heat pump operating as heating unit
B—Valve arrangement for heat pump operating as cooling unit.
1—Three-way valve
2—Four-way valve
3—Expansion valves

• Determine Heat Pump Design, Performance

A conventional refrigeration cycle was adopted to determine the capacity of the heat pump and to determine its performance characteristics. The inlet vapor to the compressor is superheated 10 F by subcooling the liquid refrigerant in an intercooler. The lowest evaporator temperature is obtained by subjecting the ground coil to supply the design heat load for a period of 48 hours without the aid of the solar collector. A temperature difference of 3 F between the coil surface temperature and transport fluid, and an additional 8 F between this fluid and the refrigerant is assumed.

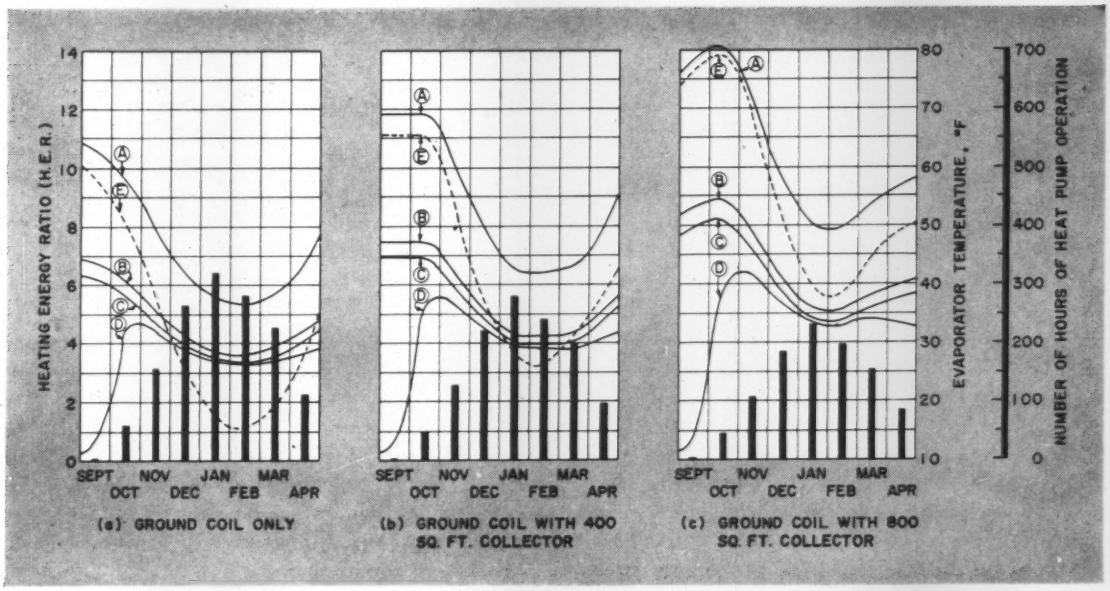
TABLE 2—THEORETICAL capacity and performance of a solar-earth heat pump operating at design conditions listed below

* Inside dry bulb temperature, F	70
* Outside dry bulb temperature, F	0
Building heat loss, Btu per hr	46,700
* Load carried by solar collector, Btu per hr	0
Average soil temperature at surface of ground coil, F	19
** Average temperature difference between ground coil and refrigerant, F	11
* Condenser temperature, F	110
* Inlet air temperature, F	68
* Exit air temperature, F	100
Weight of air circulated, lb per hr	6080
** Overall efficiency of fan motor, percent	45.5
** Capacity of fan motor, hp	0.25
** Capacity of circulating pump (ground coil), hp	0.10
** Capacity of circulating pump (solar collector), hp	0.15
Weight of refrigerant (No. 12) circulated, lb per hr	668
** Equivalent compressor displacement, cfh	984
** Overall efficiency of compressor, percent	60
** Capacity of compressor motor, hp	5.92
HER, refrigeration cycle	4.46
HER, heat pump	3.08
HER, heat pump system	2.86
Strength of heat source, Btu per hr per ft	33

* Assumed values.
** Constant factors of heat pump system at average conditions.

The lowest evaporator temperature under such conditions was found to be 8 F. The condenser temperature is assumed to be 110 F. Table 2 is a summary of the assumed and calculated data for the heat pump system when operating at design conditions.

Fig. 3a shows a flow diagram of the heat pump system when operating as a heating machine. The functions of the heat exchangers and air coil are changed by the use of two valves, shown in Fig. 3b, in converting the plant from heating to cooling. During the heating cycle, part of the air is passed through the heat pump cabinet to pick up heat losses due to inefficiencies of the equipment. In the cooling cycle, the same vent is used as an intake.


HEATING ENERGY RATIO (H.E.R.)
EVAPORATOR TEMPERATURE, °F
NUMBER OF HOURS OF HEAT PUMP OPERATION
SEPT OCT NOV DEC JAN FEB MAR APR
(a) GROUND COIL ONLY
(b) GROUND COIL WITH 400 SQ. FT. COLLECTOR
(c) GROUND COIL WITH 800 SQ. FT. COLLECTOR

4 MONTHLY PERFORMANCE of heat pump operating with ground coil and solar collector presented graphically

A—*HER** for refrigeration cycle
B—*HER* for heat pump
C—*HER* for heat pump system
D—*HER* for monthly performance
E—Evaporator temperature
Bars represent number of hours of heat pump operation.

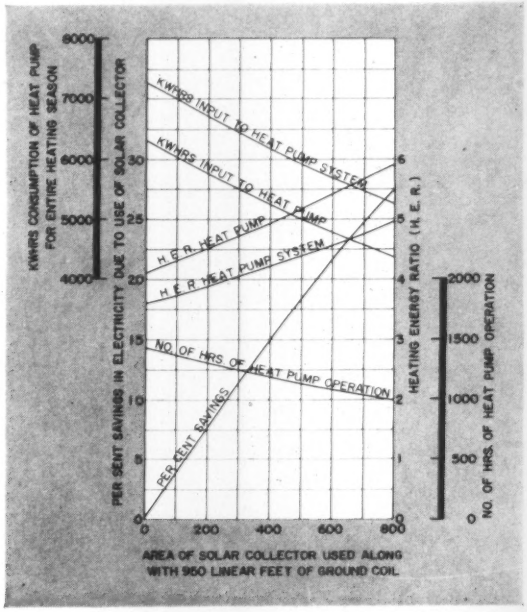
*Heating energy ratio. See footnote on page 123.

Performance of the heat pump at normal weather conditions is different from that at design conditions. Table 2 indicates the constant factors of the system that are used at average conditions. The type of refrigeration cycle used is exactly the same as that used for design conditions, the evaporator and condenser temperatures being different. The volumetric efficiency of the compressor is assumed to be constant.

Since the properties of the refrigerant before entering the compressor are known, the time rate of flow can be determined. Assuming that the overall efficiency of the compressor remains constant, isentropic enthalpy increase due to compression of the refrigerant can be determined since the input capacity of the compressor is fixed. The rest of the cycle analysis can be completed with the aid of a pressure-enthalpy chart for refrigerant No. 12, and the performance of the heat pump can be determined under operating conditions.

It is possible to calculate the number of hours the heat pump operates by the use of monthly average heating loads, assuming that the transport fluid is circulated through the solar collector only during sunshine hours and that through the ground coil 24 hours per day. The heating energy ratio is calculated for each month by properly accounting for the energy input based on the number of hours of operation of the various components of the system and the energy output.

The monthly performance of the heat pump cycle, the heat pump, and the heat pump system is shown graphically in Fig. 4, when operating with and without a solar collector. Fig. 5 presents performance data when the heat pump system operates on a seasonal basis. The data for this figure was obtained by


KWHRS CONSUMPTION OF HEAT PUMP FOR ENTIRE HEATING SEASON
PER CENT SAVINGS IN ELECTRICITY DUE TO USE OF SOLAR COLLECTOR
KWHRS INPUT TO HEAT PUMP SYSTEM
KWHRS INPUT TO HEAT PUMP
H.E.R. HEAT PUMP
H.E.R. HEAT PUMP SYSTEM
NO. OF HRS. OF HEAT PUMP OPERATION
PER CENT SAVINGS
HEATING ENERGY RATIO (H.E.R.)
NO. OF HRS. OF HEAT PUMP OPERATION
AREA OF SOLAR COLLECTOR USED ALONG WITH 950 LINEAR FEET OF GROUND COIL

5 SEASONAL PERFORMANCE of heat pump. (Additional data was obtained by similar calculations for ground coil and collectors having 200, 500, and 700 sq ft)

TABLE 3—COMPARATIVE COSTS of operation of different heating equipment on a seasonal basis

Heat pump:	With ground coil only	With ground coil and 400 sq ft solar collector	With ground coil and 800 sq ft solar collector
Electricity consumption, kwhr	7285.5	6211.9	5295.2
Saving, percent		14.7	27.3
Cost of electricity, $			
@ $0.0100 per kwhr	72.86	62.12	52.95
@ $0.0133 per kwhr	96.90	82.62	70.43
@ $0.0150 per kwhr	109.29	93.18	79.43
@ $0.0160 per kwhr	116.58	99.39	84.72
Coal furnace using best stoker coal with efficiency of 65 percent: Cost of coal @ $12.00 per ton, $			75.55*
Oil furnace using light fuel oil with efficiency of 75 percent: Cost of oil @ 15.9 cents per gallon, $			144.92*
Gas furnace using gas with efficiency of 75 percent: Cost of gas @ 76.8 cents per thousand cu ft, $			98.24

* $7.00 per season is included as cost of electricity for operating the blower which circulates warm air through the building.

adding corresponding monthly values. The *HER*'s of the heat pump and heat pump system are ratios of seasonal heat delivered to the corresponding energy supplied.

The curves in Fig. 4 representing the *HER* for the conventional refrigeration cycle are an index of the temperature limits at which the heat pump operates. The lower *HER*'s during winter months are due to lower evaporator temperature. *HER* curves for the heat pump and heat pump system under operating conditions are similar. Their deviations from the *HER*'s for the refrigeration cycle are due to inherent losses and energy input into auxiliary units. The large deviations of monthly *HER* curves during the beginning and end of the heating season are due to the long duration of operation of circulating pumps.

The energy consumed by these pumps is out of proportion to that of the compressor, thereby partly offsetting the improved performance. Since the cost of operation during these months is low, the seasonal performance is not seriously affected.

Fig. 4 shows the performance of using a solar-earth heat pump when used for space heating and Fig. 5 presents the seasonal performance of the system. On a seasonal basis for a heat pump system with a collector of 400 sq ft of surface, there is a 15 percent saving in energy consumption over a system operating without a collector.

Capacity Is Largest When Demand Is Smallest

The extent to which the heat pump operates in accordance with the reported results merits comment. For a given capacity, a heat pump having a higher *HER* indicates a larger heat rejection in the condenser. This means that the heat pump capacity is largest when the demand is smallest. Moreover, it was stated that the condenser temperature remains almost constant, which means that a large variable flow fan is necessary to pick up all the heat delivered to the condenser over a limited range of temperatures.

The large output when the demand is small will make the heat pump operate intermittently, increasing the capacity loss and warming-up period. These factors adversely affect the monthly performance reported. It is necessary to have capacity modulation of the compressors so that the heat pump will meet the variation of the building heat losses more closely and reduce intermittent operation as much as possible. With a compressor of the size required, it is economically feasible to achieve capacity modulation.

Space heating with a solar-earth heat pump can be made popular if its initial and operating costs compare favorably with conventional equipment. The cost of operation should compare favorably with other methods of space heating. The annual saving in the operating cost of a solar-earth heat pump determines the capital investment in the solar collector. Comparative costs of operation of various heating plants on a seasonal basis for Lexington, Ky., are given in Table 3. At 1.5 cents per kwhr, the cost of operating a solar-earth heat pump is more favorable than the cost of heating with natural gas. ∓

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This article is based on a paper presented at the recent meeting of the American Power Conference in Chicago.

Why Stainless Steel Is Used for Process Piping

● In last month's article, Arthur C. Wicker cited the increased use of stainless steel piping in process applications in industry, explaining its physical properties and economics as the two primary reasons for this popularity. Its ability to perform well in the process industries is made possible through the addition of various alloying agents—chromium, nickel, molybdenum, columbium, and titanium—each of which imparts certain physical properties that improve the metal to meet particular service requirements. Herein, Mr. Wicker briefly discusses the weldability of various grades of stainless steel. Also, he describes eight principal kinds of corrosion, tells how they occur, and outlines several service tests which furnish the best solution to individual corrosion problems. Included is a short review of the many applications of stainless steel piping systems in industry—and why they are used there.

Mr. Wicker is a 1948 chemical engineering graduate of the University of Louisville. As an alloy specialist, his chief interest lies in the field of corrosion and corrosion resistant piping materials. He is a member of NACE, ASM, SPE, and AICE.

BY ARTHUR C. WICKER
Alloy Specialist
Tube Turns Div.
Chemetron Corp.

STAINLESS STEEL pipe is readily welded when proper procedures are followed. Since fabrication techniques are dealt with in standard literature, the following discussion is devoted mainly to the relative weldability of the principal stainless steels, and to other related considerations.

200 Series: The welding properties of the 200 Series are virtually the same as those of the 300 Series, although the materials in the 200 Series are a little less susceptible to carbide precipitation.

300 Series: Materials in the 300 Series serve an estimated 95 percent of all of industry's stainless steel piping requirements. Correctly made welds are tough and ductile and have the same corrosion resistance as the base metal. If the welded assembly is to be subjected to severe corrosive attack, it should be annealed after welding, or the extra low carbon or stabilized

alloys should be used. Stabilized grades are not as easy to weld as unstabilized grades.

400 Series: The ferritic stainless steels of the 400 Series are not as weldable as the austenitic materials, but they can be satisfactorily joined by employing any of the conventional welding procedures not entailing the use of the hammer or forge. If properly annealed after welding, they are quite tough and ductile and have good mechanial properties, although these properties are not equal to those possessed by welded austenitic materials.

The martensitic materials in the 400 Series require preheating, post-heating, or both, and it is desirable to fully anneal them after welding.

Eight Kinds of Corrosion

The engineer faced with a problem of designing a piping system subject to corrosive conditions must know how corrosion works and its relation to all types of metals and alloys that are commercially available. Only then will he achieve the most satisfactory and economical results.

There are eight principal kinds of corrosion. Generally speaking, the amount of resistance required to withstand corrosive attack on stainless steels (or any other materials) depends on the corrodent being conveyed by the piping and the impurities that may be present, and the pressure, temperature and other service conditions.

Service tests furnish the best solution to individual corrosion problems. That is, sections of piping are fabricated of materials that seem most suitable, then installed in the system and their merits evaluated.

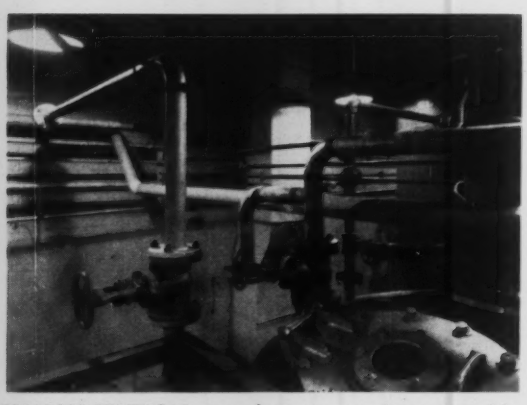
Galvanic corrosion occurs when two dissimilar metals or two pieces of the same metal at different potentials are coupled in the presence of an electrolyte. The anode, or less noble metal, is attacked and the cathode, or more noble metal, is not usually harmed. However, there are circumstances where the products of corrosion may attack the cathode. In order to estimate the extent of potential galvanic corrosion, reference should be made to the table of the electromotive force series (standard electrode potentials) of metals and the galvanic series found in the Corrosion Handbook, the Chemical Engineers' Handbook, the Piping Handbook, and other reference sources. The greater the separation between two metals in the series, the more likely it is that galvanic corrosion will occur.

Pitting corrosion may be experienced with any metal. Corrosion of this kind is initiated by the breaking down of passive surface film at some point. This frequently occurs underneath some deposit or at a nonmetallic inclusion. Once the film is broken, the bare metal becomes anodic with respect to the remaining oxide film. This results in a small electrolytic cell with a minute anodic area and a relatively large cathodic area. Under these conditions the attack on the anode proceeds very rapidly and leaves small pin holes, or pits, in the material. Stainless steels generally resist pitting in most environments, but the presence of acidic chloride ions always constitutes a threat of pitting corrosion and/or stress-corrosion cracking.

Crevice corrosion may occur adjacent to or beneath a crevice, such as one formed by socket welding. Perhaps it can best be described as the formation of a galvanic cell. It can take place under a variety of circumstances presented by gaskets, marine growth, rivet or bolt heads, washers, protective coatings, etc.

In some unstabilized stainless steels that have been heated for a length of time in the range of 850 to 1650 F, *intergranular corrosion* may be found. As stated last month, chromium-rich carbides precipitate to the grain boundaries and the areas adjacent to the boundaries are depleted of chromium. The result is that conditions are set up for a galvanic cell in which the impoverished grain boundaries are anodic to the interior of the grain. This kind of corrosion is commonly avoided by (1) using stablized grades of stainless steel, (2) employing ELC "low carbon" types of stainless steel, and (3) properly annealing the piping assembly from a temperature of about 2000 F after welding.

Stress-corrosion cracking is the acceleration of the rate of corrosion damage by static stress. Thus, relatively low stresses can initiate cracking. For this reason, stainless steel intended for corrosive service should not be used in the cold-worked condition, since cold work leaves the material in a state of high residual stress. Stress corrosion failure is usually associated with certain environments — often one which brings about only a superficial corrosive attack on the metal when stresses are absent. The acid chlorides are most frequently identified with stress-corrosion cracking in stainless steels.



PHARMACEUTICAL manufacturers use large quantities of stainless steel piping for applications that require high degree of protection against product contamination, such as this penicillin processing line

STAINLESS STEEL GLOSSARY

Aeration: Mixture of air or oxygen with chemical solutions, usually acids; ready availability of air or oxygen for chemical reactions means an increase in rate of corrosion.

Anode: Electrically positive pole is an electrolytic cell; pole at which oxidation occurs; the less noble metal in the galvanic series.

Austenitic: Type of crystalline structure of metal (nonmagnetic).

Cathode: Electrically negative pole in an electrolytic cell; more noble metal in galvanic series.

Electrolyte: Media capable of carrying an electric current; in galvanic corrosion, the electrolyte carries current between dissimilar metals.

Ferritic: Type of crystalline structure of metals (magnetic).

Halogen: Chemically related family of elements consisting of fluorine, chlorine, bromine, iodine.

Ion: Electrically charged atom or molecule.

Martensitic: Type of crystalline structure of metals (magnetic).

Neutral chloride solution: Solution of a chloride salt which is neither acidic nor alkaline.

Oxidation: Type of chemical reaction in which electrons are given up; usually thought of in combination with oxygen.

Oxidizing agent: Chemical which readily takes on electrons; lends itself strongly to oxidation.

Passivity: Resistance to chemical corrosion; usually maintained by the formation of a thin invisible coating of metal oxide which strongly resists further oxidation (corrosion).

Reduction: Type of chemical reaction in which electrons are gained; opposite of oxidation.

Salt: Chemical compound formed by the reaction of an acid with a base.

The concurrent action of cyclic stressing and corrosion may bring about *corrosion fatigue*. As in stress-corrosion cracking, intergranular corrosion and pitting act as stress raisers. A metal's resistance to corrosion fatigue depends largely on its ability to offer direct resistance to corrosion; but it is also affected by the nature of the corroding medium, kind and range of stress, rate of stressing, temperature, degree of aeration, and the physical properties of the material.

Surface damage that occurs when two surfaces are in vibrating contact under high loads is often called *fretting corrosion*. Corrosive attack is increased because of the erosive effect present. The situation is usually corrected by (1) the application of a lubricant or by (2) increasing the friction between the two surfaces and reducing slippage.

The eroding action of fluid at high velocity is the chief cause of *impingment* and *erosion corrosion*.

Impingment corrosion is generally associated with turbulent flow, while erosion corrosion attack is generally associated with the abrasive action of liquids and gases.

Since the kind of corrosion referred to here stems from the loss of the protective surface oxides, those metals with highly adherent films are more resistant to attack. The stainless steels have an exceedingly tough surface and are not usually subjected to this type of deterioration.

Corrosion Tests Devised

A number of laboratory tests have been devised to measure the corrosion resistance of stainless steels. Among those most frequently used are the Strauss test, the Huey test, and the penetrant tests.

The Strauss test determines carbide precipitation. Specimens of Types 304L and 347 steels, which are not normally sensitive to carbide precipitation, are first heated in the sensitizing range of 800 to 1500 F to purposely bring about chromium segregation, if a lot of material is susceptible to this form of deterioration. This temperature range is used because these steels are intended to be suitable under such conditions of temperature which exist, for example, in the zone adjacent to a joint that is being welded. The next step is to immerse the specimens in a boiling solution of copper sulfate and dilute sulfuric acid for a period of three days. Finally, they are removed from the solution and bent around a mandrel. If intergranular corrosion has been severe, the specimens will crack, thus indicating that the lots of material from which they were taken have relatively poor corrosion resistance.

In evaluating the corrosion resistance of Types 304 and 316 steels, the sensitizing treatment is not given, since these materials are known to be subject to carbide precipitation in the 800 to 1500 F range.

The Huey test, on the other hand, measures the general corrosion resistance of stainless materials. As in the Strauss test, and for the same reason, Types 304L and type 347 steels are sensitized by heating in the 800 to 1500 F range. Then they are immersed in boiling nitric acid for six of 10 days. The loss in thickness, which is calculated by the loss of weight, is an indication of the amount of corrosion resistance offered by the material.

Test for Surface Defects

Two forms of penetrant tests are commonly used on stainless steel to reveal surface defects that may lead to corrosion.

The first, a penetrant dye test, is employed in checking cracks in and the porosity of the nonmagnetic stainless materials. A red liquid dye is applied to the fitting or flange being examined. It penetrates into defects, then bleeds out to reveal them easily in ordinary light. The depth of flaws is not made apparent by this test and not until they are removed can

it be determined if they are sufficiently serious to cause rejection of the product.

The second is a fluorescent penetrant test, which is used less frequently in inspecting fittings and flanges. In this method a fluorescent oil penetrates into cracks and other flaws that reach the surface. After the excess oil is cleaned off, the oil bleeds out of these voids and under a fluorescent light all surface defects are readily seen. The depth of the defects is not indicated and they must be removed before deciding that the product is or is not acceptable.

Applications for Many Piping Services

Piping of stainless materials is employed so extensively that it is not possible to catalogue individual applications, but a short review of the more important ones may prove enlightening.

Stainless steel's corrosion resistance and high temperature properties have made it a preferred material in the petrochemical field. The materials employed range from those with 12 percent chromium content, which find service in welded assemblies operating at temperatures below 1200 F, to the 25 percent chromium-20 percent nickel steels used under extreme conditions of corrosion and oxidation at high temperatures about 1500 F. But the greatest amount of stainless steel specified for refinery service falls into the 300 series, or the 18-8 group, as it is often called. These materials are employed in the construction of thermal cracking units, lube oil phenol extraction units, fluid catalytic units, vacuum stills and other pieces of equipment.

In the pharmaceutical industry, stainless steel piping permits processors to meet rigid quality standards. It not only protects their products from contamination, but from discoloration and changed taste as well. For these reasons they use it on a large scale.

Piping of stainless alloys is employed in the manufacture of penicillin, streptomycin, and many other antibiotics and medicinal drugs; creams, ointments, elixirs, extracts, pills, biologicals, and other pharmaceutical compounds.

In the plastics industry, stainless steels are used extensively in the manufacture of cellulose, formaldehyde resins, alkyds, acrylics, vinyls, styrene copolymers, and other plastics materials. Although corrosive attack is not as severe as with inorganic reactions involving strong acids, control over color impurities must be rigidly maintained. Stainless steels offer excellent protection against color contamination by products of corrosion. Distillation and fractionating towers, heat exchangers, reactors, piping, valves, and pumps are usually fabricated in whole or in part of stainless alloys.

Food processors were among the first to employ stainless steel. It enables them to establish the sanitary conditions required by law and their own high standards. Additionally, stainless steel enables them to guard their products against discoloration and changed taste that might otherwise be brought about by corrodents.

Much stainless steel piping in the food processing industries is connected by means of sanitary fittings, so that it can be rather quickly dismantled and cleaned at short intervals—often daily. However, some processors are experimenting with all-welded stainless steel pipe, fabricated with welding fittings. Based on their encouraging reports, it is expected that an increased amount of welded piping will be used in this industry, where it can be demonstrated to local sanitary officials that welded construction does not have an adverse effect on the edibles being handled.

In low temperature service, stainless steel retains its high tensile and yield strength, ductility, and toughness at extremely low temperatures. In addition, it has the very low heat transfer properties — at low temperatures — needed to maintain gases in a liquid state. Some of the most interesting low temperature applications are in the manufacture, storage, and transportation of liquid oxygen, hydrogen, and nitrogen. The production of liquefied petroleum gases is expected to offer another new and challenging market for stainless steels.

The remarkable growth of the chemical process industries has been accompanied by a vast increase in the amount of stainless steel piping employed to meet the exacting service conditions encountered. All types of stainless steel materials are specified, and most of the critical piping is of welded construction.

Stainless steels are employed for handling, storing, heating, cooling, separating and mixing nitric, sulfuric, phosphoric, acetic, and other acids and their salts. These industries are largely responsible for quickening the development of new stainless steels and hastening the introduction of improved methods of fabricating these materials.

The useful application of wrought heat-resisting steels and alloys is becoming increasingly important in piping for steam power plants, the rocket and missile field, nuclear services and for other equipment that operates at elevated temperatures. Primary requirements for piping materials to be used in such applications include resistance to creep or rupture, resistance to oxidation, and reasonable stability of structure so as to avoid detrimental changes in properties during service. These requirements are met to a greater or lesser degree by the various stainless steels discussed in this article. The alloys of the 18-8 group, particularly, have been used successfully in many applications requiring strength, ductility, and scaling resistance at high temperatures, e.g., Type 304 for nuclear power applications and Type 347 for supercritical steam power generating plants. ∓

the law and your profits

JOHN F. MORRISSEY, author of this regular feature, is an attorney at law and has an extensive practical business and legal background. This series is based on actual cases. All names are, however, fictitious. It should, of course, be remembered that the law varies in different states.

Protect Yourself; You Can Be Held Liable For Negligent Acts by Your Employees

WHAT ARE the responsibilities of an employer to persons injured or damaged by the negligent act of an employee? It is quite commonly understood that the law holds the employer liable for such acts of employees if they are committed in the course of their employment. This principle sounds simple enough, but its application to a factual situation is sometimes difficult, as you will see in the following case:

T. O. Mutch Heating Co., a heating contractor, leased and occupied one-half of a large building, the other half of which was occupied by the Vic Timm Corp., a manufacturer of plastic toys.

Charley Few worked on the premises for Mutch. Charley and his fellow employees were forbidden to smoke on the premises except in the washrooms. Near an aisle leading to one of the washrooms was a 50 gal drum containing paint thinner. Near the drum was a fire extinguisher.

One afternoon Charley decided to have a cigarette. Having no matches, he stopped at the drum on his way to the washroom to fill his lighter with the thinner fluid. He opened the spigot on the drum and at the same time, but unintentionally, he pressed the button on the lighter. The spark ignited the thinner.

Before the fire could be put under control the entire building had been seriously damaged. A lawsuit was filed by Vic Timm against Mutch for damages occasioned by the fire.

In court, there was no conflict as to the cause of the fire. But at the end of testimony, Mutch asked the court to instruct the jury to make a finding of not guilty.

"As a matter of law," argued Mutch, "Timm has failed to make out any case against our company. Granted, Charley was negligent in causing the fire. But he was not acting within the course of his employment at the time. He was a punch press operator and his duties had nothing to do with the drum of thinner.

"Going to the washroom for a cigarette and stopping to fill a lighter with thinner are strictly personal acts for which we cannot be held responsible. The act which caused the fire was a substantial departure from his employment."

The court agreed and instructed the jury to find Mutch not guilty. Vic Timm appealed the case to a higher court, contending that the lower court had erred.

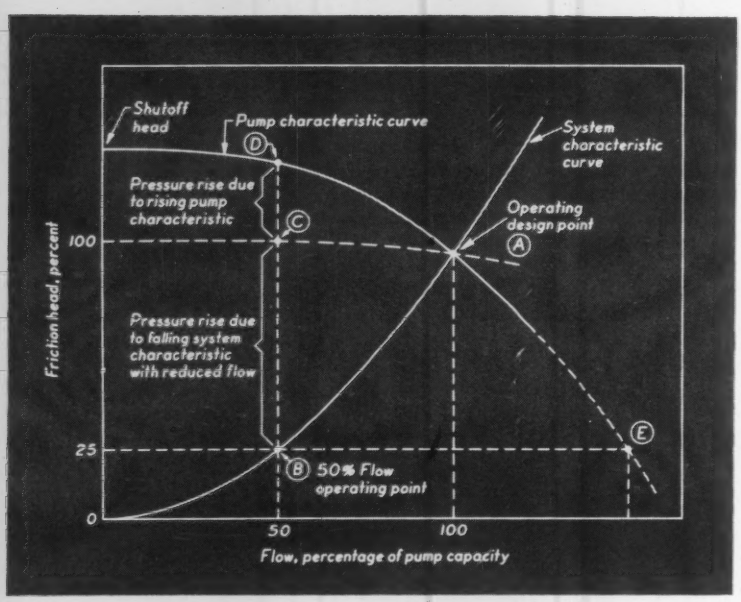
The higher court recognized the fact that the limits of the phrase, "in the course of employment," are uncertain. It stated that, as a general rule, whatever is done by an employee in furtherance of his employer's business is deemed to be in the course of his employment. It is proper to inquire whether he was at the time engaged in serving his employer. It is not necessary that he should have authority to do the act which resulted in the loss.

However, the higher court held, an employee does not cease to be acting within the course of his employment because of an incidental personal act if his main purpose is still to carry on the business of his employer. In order to release an employer from liability, the deviation must be so substantial as to amount to an entire departure.

Charley's purpose in attempting to fill his lighter was so that he could enjoy the comfort of smoking in the washroom — his privilege. His main purpose was to pursue an act which, although personal, was necessarily contemplated by his employer and which, therefore, was in the course of his employment.

The case was sent back to the lower court where the jury found in favor of Vic Timm.

If there is a lesson in this case, it would seem to be that the best way for an employer to avoid liability for the negligent acts of employees is to prevent such acts by adequate safety precautions. However, as perhaps Mutch may have learned, this is no guarantee. ∓



1 FLOW CHARACTERISTICS of typical closed circulating hot water heating system are plotted at left

A CONSULTING ENGINEER SAYS:

'Direct Throttling Is Good Hot Water Pressure Control'

• Poor pressure control can be the downfall of the best of hot water heating systems. Various pump bypass methods that are commonly used to regulate flow either do not take into account the falling pressure characteristic or else they cause some other operating shortcoming. This article will point out how these pressures vary and will suggest one method—direct throttling—for controlling them.

BY J. W. SCHARRES
Chief Engineer
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Consulting Engineers

IT HAS long been the practice in the control of forced circulation hot water heating systems to modulate the temperature of the circulating water from a central point as a primary control, and to modulate the flow of water to each individual room convector as a secondary or room control.

Whenever flow is changed in a piping system, pressure drops change because the frictional resistance of the system is altered. In order to effectively control the flow in a system, these pressure drops must be regulated. It is the purpose of this article to point out how these pressures vary and to suggest better methods of controlling them than are now commonly used.

Fig. 1 shows the typical flow characteristics of a closed circulating system with the pump curve plotted on the same flow *vs* head coordinates as the system curve. Such a system will operate at point *A*, which is the intersection of the two curves and, for pur-

poses of this analysis, is the point at which the system is designed to circulate under maximum load conditions.

Now, suppose that the throttling valves on the convectors, in response to their room thermostats, close sufficiently to reduce the water flow in the system to 50 percent of the design point. If this reduction in flow is accomplished, the frictional resistance of the piping system will fall to 25 percent of the design point because frictional resistance in a piping system varies directly as the square of the flow. This operating point of the system is shown at point *B* in Fig. 1. If the pump is to operate at 50 percent flow, its pressure must rise to point *D*.

Must Control Excess Pressure

It is apparent that, if on reduced flow the pump pressure must go up and the system friction must go down, something must use up the excess pressure (*B*, *C*, and *D*).

If no separate means of pressure regulation is provided, this excess pressure will exert itself across the convector control valves, causing them to have considerably more pressure across them when they are partially closed than when they are fully open. The obvious result would be very poor control of flow, even with a highly characterized inner valve.

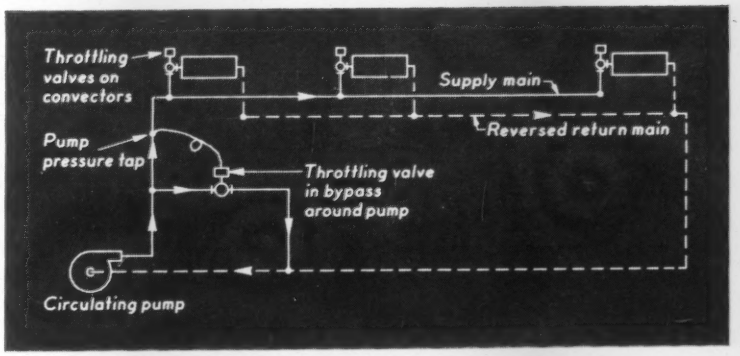
To correct this situation some sort of pressure regulation is commonly used on circulating systems.

One of the earliest methods of pressure control is the simple bypass type of pump discharge pressure regulator shown in Fig. 2. This arrangement keeps pump pressure constant from a pressure tap in the pump discharge line. Excess water not required by the convectors is shunted through the bypass, thus keeping the pump operating at point *A* and compensating for the rising pressure characteristic of the pump (*C* and *D*).

This method does nothing about the falling pressure characteristic of the system (*B* and *C*) and therefore falls far short of contributing to good control.

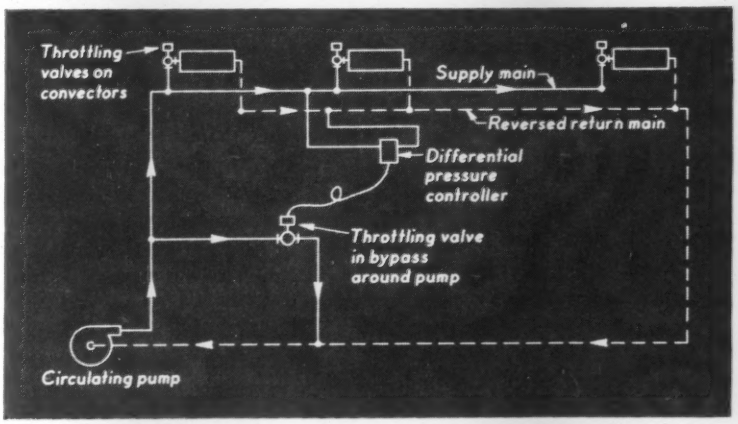
An improvement in control is

WRONG—



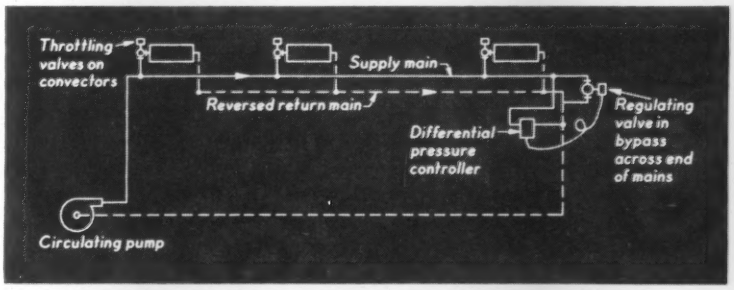
2 PUMP BYPASS type of discharge pressure regulator keeps pump pressure constant from pressure tap in pump discharge line. Arrangement does nothing about falling pressure characteristic of system

WRONG—



3 DIFFERENTIAL pressure regulator controls pressure drop across each convector branch and, consequently, across each valve. But method is not always effective, since, to accomplish proper operating condition, pump must handle more water, requiring pump operation at excessive power input

WRONG—



4 THIS VARIATION has pump bypass located at end of mains in attempt to keep flow and pressure drop constant. Since mains would have to be full size through their entire length, cost would be prohibitive

shown in Fig. 3. Instead of merely regulating pump pressure, this arrangement utilizes a differential pressure regulator to control the pressure drop across each convector branch and, consequently, across each control valve. Since the system has a reversed return, the controller pressure taps across the supply and corresponding reversed return main will effectively sense the drop across all convector circuits.

This sensing and regulation of pressure drop is the important objective of all flow control methods because, if the pressure drop across a throttling valve is constant, the flow will be proportional to its stem lift or to its port area.

Bypass Not Always Effective

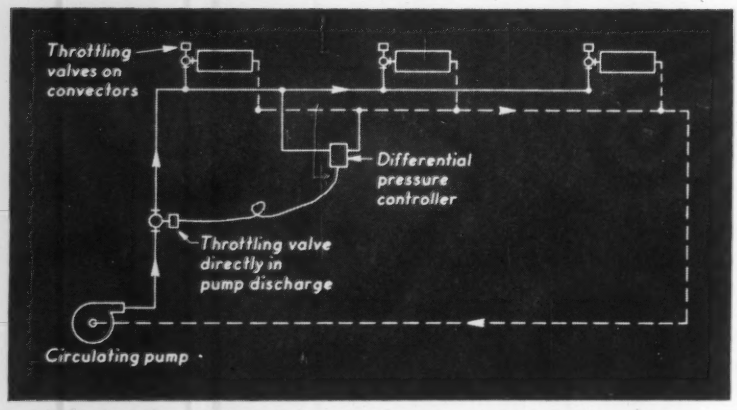
Careful analysis shows, however, that the pump bypass method of pressure regulation is not entirely effective. If, for 50 percent flow in the circuit, the pump pressure is to be kept at the 25 percent level, the pump must operate at point *E* on its curve. This is indicated in Fig. 1. To accomplish this condition, the pump bypass must handle enough water to increase the flow rate considerably beyond the design or 100 percent point. The pump then operates at greater power input than that at which it was selected, and there is some danger that the motor will be overloaded.

It must be pointed out also that the inherent characteristic of many pump impellers is such that they cannot be made to operate far enough out on their curves beyond the design point to reduce the total dynamic head to 25 percent of design conditions. The pump bypass method of pressure regulation therefore leaves much to be desired as a method of control and may be classed with the foregoing as incorrect.

A variation of the pump bypass that has been advocated is shown in Fig. 4. It differs only in that the bypass is located at the end of the mains in an effort to keep the flow in the mains constant at all loads and thereby keep the pressure drop constant.

Since full flow in the mains is required at times when there is no flow in the convectors, the mains would then have to be full size for their entire length in order to accommodate full flow. Such mains would certainly rule out this method, because they would be too costly in most instances. The method is open also to the same objections as that of the pump bypass and therefore is ineffective as well as uneconomical.

RIGHT—



5 IMPROVED METHOD, using practically same equipment, has control valve placed directly in pump discharge where it simply throttles flow. Pressure drop is taken up by throttling valve. Arrangement results in operating cost savings

Here's an Improved Method

Fig. 5 shows an improved method using practically the same equipment. The differential pressure regulator remains the same as before, but the control valve is placed directly in the pump discharge where it simply throttles the flow. Fig. 1 indicates that, for the 50 percent flow point, the pump will operate at point *D* on its curve while the piping system operates at point *B* on its curve. The pressure drop indicated by *B*, *C*, and *D* is taken up by the throttling valve.

Note that by actually reducing the pump flow, the power is reduced, thus resulting in a saving in operating cost because most of the time a heating system operates at less than full load. This is in contrast to the bypass method of Fig. 3 which actually takes more power at half load than it does at full.

The direct throttling method illustrated in Fig. 5 is therefore suggested as the correct method of pressure control for hot water heating circulating systems. ≠

CE Firm To Retain Old Partnership Name

SEELYE STEVENSON VALUE & KNECHT, mechanical, industrial, electrical, civil, and structural consulting engineering firm with offices in New York City and New Rochelle, N.Y., has announced its intention of continuing the firm's practice under the above name subsequent to the death of the senior partner, Elwyn E. Seelye, on December 28, 1959.

Present partners in the firm are Albert L. Stevenson, Burnside R. Value, A. Wilson Knecht, E. B. J. Roos, S. D. Teetor, H. S. Woodward, and W. D. Bailey. Each member heads a division of the organization in which he specializes. ≠

Directory of Addresses for Engineering Societies, Associations

Acoustical Society of America, 335 E. 45th St., New York 17, N. Y.

Air-Conditioning and Refrigeration Industry Safety Committee, 1346 Connecticut Ave., N. W., Washington 6, D. C.

Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D. C.

Air-Conditioning and Refrigeration Wholesalers, 21877 Euclid Ave., Cleveland 17, O.

Air Cooling Institute, P.O. Box 2121, Wichita Falls, Tex.

Air Distribution Institute, 2130 Keith Bldg., Cleveland 15, O.

Air Filter Institute, Box 9325, Washington 5, D. C.

Air Moving and Conditioning Association, Inc., 2159 Guardian Bldg., Detroit 26, Mich.

Air Pollution Control Association, 4400 Fifth Ave., Pittsburgh 13, Pa.

Air Pollution Foundation, 2556 Mission St., San Marino, Calif.

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American Boiler Manufacturers Association, 1180 Raymond Blvd., Newark 2, N. J.

American Concrete Institute, 22400 W. Seven Mile Rd., P.O. Box 4754, Redford Sta., Detroit 19, Mich.

American Foundrymen's Society, Golf and Wolf Rds., Des Plaines, Ill.

American Gas Association, 420 Lexington Ave., New York 17, N. Y.

American Industrial Hygiene Association, 14125 Prevost, Detroit 27, Mich.

American Institute of Architects, 1735 New York Ave., N.W., Washington 6, D.C.

American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

American Institute of Plant Engineers, P.O. Box 185, Barrington, Ill.

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American Meteorological Society, 45 Beacon St., Boston 8, Mass.

American Nuclear Society, 86 E. Randolph St., Chicago 1, Ill.

American Petroleum Institute, 1271 Ave. of the Americas, New York 20, N.Y.

American Rocket Society, 500 Fifth Ave., New York 36, N. Y.

American Society of Agricultural Engineers, 420 Main St., St. Joseph, Mich.

American Society for Engineering Education, University of Illinois, Urbana, Ill.

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 234 Fifth Ave., New York 1, N. Y.

American Society of Heating, Refrigerating and Air-Conditioning Engineers Research Laboratory, 7218 Euclid Ave., Cleveland 3, O.

American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

American Society of Safety Engineers, 5 N. Wabash Ave., Chicago 2, Ill.

American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

American Standards Association, 10 E. 40th St., New York 16, N. Y.

American Welding Society, Inc., 33 W. 39th St., New York 18, N. Y.

Anthracite Institute, 237 Old River Rd., Wilkes-Barre, Pa.

Association for Applied Solar Energy, Arizona State University, Tempe, Ariz.

Atomic Industrial Forum, Inc., 3 E. 54th St., New York 22, N. Y.

Better Heating-Cooling Council, 250 Park Ave., New York 17, N. Y.

Bituminous Coal Institute, 1130 17th St., N.W., Washington 6, D. C.

Bituminous Coal Research, Inc., 121 Meyran Ave. at Forbes Ave., Pittsburgh 13, Pa.

Building Research Advisory Board, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington 25, D. C.

Building Research Institute, National Academy of Sciences-National Research Council, 2101 Constitution Ave., Washington 25, D. C.

Clay Flue Lining Institute, 161 Ash St., Akron 8, O.

Clay Sewer Pipe Association, Inc., 311 High-Long Bldg., 5 E. Long St., Columbus 15, O.

Code for Pressure Piping, ASA Sectional Committee B31, Room 647, 420 Lexington Ave., New York 17, N. Y.

Committee on Steel Pipe Research, American Iron and Steel Institute, 150 E. 42nd St., New York 17, N. Y.

Compressed Air & Gas Institute, 122 E. 42nd St., New York 17, N. Y.

Construction Specifications Institute, 632 Dupont Circle Bldg., Washington 6, D. C.

Consulting Engineers Council, 326 Reisch Bldg., Springfield, Ill.

Cooling Tower Institute, 1120 W. 43rd, Houston 18, Tex.

Copper and Brass Research Association, 420 Lexington Ave., New York 17, N. Y.

Copper Products Development Association, Inc., 25 Broadway, Room 1810, New York, N. Y.

Diamond Core Drill Manufacturers Association, 122 E. 42nd St., New York 17, N. Y.

Edison Electric Institute, 750 Third Ave., New York 17, N. Y.

Electrical Institute of Washington, Pepco Bldg., 10th and E Sts., N.W., Washington 4, D. C.

Environmental Equipment Institute, 9 Spring St., Princeton, N. J.

Expansion Joint Manufacturers Association, 53 Park Place, New York 7, N. Y.

Fluid Controls Institute, Inc., P.O. Box 667, Pompano Beach, Fla.

Formed Steel Tube Institute, 1604 Hanna Bldg., Cleveland 15, O.

Fuel Oil & Water Heater Manufacturer's Association, P.O. Box 151, East Greenwich, R. I.

Gas Appliance Manufacturer's Association, 60 E. 42nd St., New York 17, N. Y.

Gas Vent Institute, 322 S. Michigan Ave., Chicago 4, Ill.

(Continued on next page)

Heat Exchange Institute, 122 E. 42nd St., New York 17, N. Y.
Hydraulic Institute, 122 E. 42nd St., New York 17, N. Y.
Industrial Heating Equipment Association, Inc., Associations Bldg., Washington 6, D. C.
Industrial Gas Cleaning Institute, c/o American Air Filter Co., 215 Central Ave., Louisville 8, Ky.
Institute of Boiler and Radiator Manufacturers, Room 408, 608 Fifth Ave., New York 20, N. Y.
Institute of Environmental Sciences, P.O. Box 191, Mt. Prospect, Ill.
Institute of Heating & Air Conditioning Industries, Inc., 5107 W. First St., Los Angeles 4, Calif.
Institution of Heating and Ventilating Engineers, 49 Cadogan Sq., London, S. W. 1, England.
Instrument Society of America, Granite Bldg., 313 Sixth Ave., Pittsburgh 22, Pa.
Insulation Board Institute, 111 W. Washington St., Chicago 2, Ill.
Insulation Distributor-Contractors National Association, Inc., 1425 Chestnut St., Philadelphia 2, Pa.
Liquefied Petroleum Gas Association, 11 S. LaSalle St., Chicago 3, Ill.
Manufacturers' Standardization Society of the Valve & Fittings Industry, 420 Lexington Ave., New York 17, N. Y.
Mechanical Contractors Association of America, Inc., (formerly Heating, Piping & Air Conditioning Contractors National Association), Suite 570, 45 Rockefeller Plaza, New York 20, N. Y.
Mines Accident Prevention Association of Ontario, Canada Permanent Bldg., 320 Bay St., Toronto 1, Ontario, Canada
Modular Building Standards Association, 2029 K St., N. W., Washington 6, D. C.
National Association of Building Owners and Managers, 134 S. LaSalle St., Chicago 3, Ill.
National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Tex.
National Association of Pipe Nipple Manufacturers, Inc., 501 Fifth Ave., New York 17, N. Y.
National Association of Power Engineers, Inc., 176 W. Adams St., Chicago, Ill.
National Association of Practical Refrigerating Engineers, 435 N. Waller Ave., Chicago 44, Ill.
National Board of Boiler & Pressure Vessel Inspectors, 1155 N. High St., Columbus, O.
National Board of Fire Underwriters, 85 John St., New York 38, N. Y.
National Bureau of Standards, Building Technology Div., Air Conditioning, Heating & Refrigeration Section, Washington 25, D. C.
National Certified Pipe Welding Bureau, Suite 570, 45 Rockefeller Plaza, New York 20, N. Y.
National Coal Association, Southern Bldg., Washington 5, D. C.
National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.
National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N. Y.
National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.
National Heating & Cooling Sales Association, Inc., 50 Commerce St., Newark 2, N. J.
National Humidification Association, Inc., 20211 Harvard Ave., Cleveland 22, O.
National Insulation Manufacturers Association, 441 Lexington Ave., New York 17, N. Y.
National Mineral Wool Association, 1270 Sixth Ave., Rockefeller Center, New York 20, N. Y.
National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.
National Society of Professional Engineers, 2029 K St., N.W., Washington 6, D. C.
National Swimming Pool Institute, 48½ N. Ayer St., Harvard, Ill.
National Warm Air Heating and Air Conditioning Association, 640 Engineers Bldg., Cleveland 14, O.
NorthAmerican Heating & Airconditioning Wholesalers Association, 1200 W. Fifth Ave., Columbus 12, O.
Oil-Heat Institute of America, Inc., 500 Fifth Ave., New York 36, N. Y.
Perlite Institute, Inc., 45 W. 45th St., New York 36, N. Y.
Pipe Fabrication Institute, Room 759, One Gateway Center Pittsburgh 22, Pa.
Plumbing-Heating-Cooling Information Bureau, 35 E. Wacker Dr., Chicago 1, Ill.
Producers' Council, Inc., 2029 K St., N.W., Washington 6, D. C.
Radiant Heating and Cooling Institute, Suite 318, 5657 Wilshire Blvd., Los Angeles 36, Calif.
Refrigeration and Air Conditioning Contractors Association, 1028 Connecticut Ave., N. W., Washington 6, D. C.
Refrigeration Research Foundation, 12 N. Meade Ave., Colorado Springs, Colo.
Refrigeration Service Engineers Society, 433 N. Waller Ave., Chicago 44, Ill.
Refrigeration Trade Association of America, Room 513, Perpetual Bldg., 1111 E St., N.W., Washington 4, D. C.
Sheet Metal and Air Conditioning Contractors National Association, Inc., 107 Center St., Elgin, Ill.
Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y.
Society of Fire Protection Engineers, 60 Batterymarch St. Boston 10, Mass.
Society of Plastics Engineers, Inc., 65 Prospect St., Stamford, Conn.
Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y.
Steam Heating Equipment Manufacturers Association, 5200 W. Clinton Ave., Milwaukee 18, Wis.
Steel Boiler Institute, Inc., 1308 Land Title Bldg., Philadelphia 10, Pa.
Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1, Ill.
Sump Pump Manufacturers Association, Mills Bldg., Washington 6, D. C.
Tubular Exchanger Manufacturers Association, Inc., 53 Park Pl., New York, N. Y.
Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago 11, Ill.
Uniform Boiler and Pressure Vessel Laws Society, Inc., 95 Liberty St., New York 6, N. Y.
United Association of Journeymen & Apprentices of the Plumbing & Pipefitting Industry of the United States and Canada, United Association Bldg., 901 Massachusetts Ave., N. W., Washington 1, D. C.
Valve Manufacturers Association, 60 E. 42nd, St., New York 17, N. Y.
Vertical Turbine Pump Association, 400 Citizens Bank Bldg., 16 N. Marengo Ave., Pasadena, Calif.
Warm Air Heating Institute of Northern California, 870 Market St., San Francisco 2, Calif.
Water Conditioning Foundation, 1201 Waukegan Rd., Glenview, Ill.
Western Air Conditioning Industries Association, 3443 S. Hill St., Los Angeles 7, Calif.

How to Operate Induction Unit Systems When Changeover Point Is Subfreezing

Modified system boosts efficiency during mild weather

• The operation of an induction unit air conditioning system can be greatly improved by incorporating some minor changes in the conventional piping hookup and controls. The system described in this article will function on the modified method of operation only between the periods when the outdoor air temperature is between 40 F and the changeover point.

During mild weather, a conventional induction unit system is very inefficient if it has to be operated on the summer cycle. The operating efficiency of the whole system will be improved, to a certain extent, during the periods the system will function on modified operations.

The modified system will facilitate the use of the heat rejected into the condenser of the refrigerating machine for providing reheat to the primary air. Therefore, when the outdoor air temperature is below 40 F, the use of the cooling tower will not be necessary, so there will be no freeze-up problem.

In the modified system, the low changeover point imposes no operating problem. Therefore it will be possible to keep the primary air supplied to the space to the minimum acceptable limit. This will result in savings in primary air ductwork and building space occupied by the mechanical equipment, and, in some applications, will eliminate the return air fan and ductwork. Likewise, it will permit the use of larger glass areas for the skin of the building, as well as enable the use of greater lighting loads in the space without jeopardizing system operation.

BY HEM C. GUPTA
Design Engineer
A. Epstein and Sons, Inc.
Consulting Engineers

RECENT YEARS have seen a steady increase in the use of glass in big building architecture. This, coupled with high lighting loads, results in greatly increased cooling requirements for building perimeter areas. An induction unit system offers many apparent advantages for air conditioning this type of structure, some of which are:

1) Independent modular room control
2) Much less space required for air handling equipment
3) Much less ductwork required, resulting in a greater percentage of usable space in the building.

Along with these advantages, however, this type

of system is very critical in its function under certain operating conditions. These must be recognized at the design stage. The greater cooling load resulting from the increased use of the glass and the higher lighting loads makes its operation even more critical.

The system is designed to function on so-called "summer" and "winter" cycles through a manual or automatic changeover switch. Theoretically, the system would be changed from summer to the winter cycle on the slight decrease in the outdoor air temperature below the changeover point, and vice versa. This changeover occurs at an outdoor air temperature when the total internal cooling load in the space, due to solar load, lighting, and people, is equal to the combined cooling available to the space from the primary air and the transmission loss through the space.

Because of the rather small quantity of primary air supplied to the induction units, the cooling effect available from it is very limited, even though its temperature (winter cycle) is much lower than the temperature of the air in the all-air system. Therefore, the balance of energy between the cooling load in the space and the cooling capacity available occurs at rather low outdoor air temperatures.

The system thus has to be operated on the summer cycle even when the outdoor air temperature is considerably lower than the space design temperature. Since, during the summer cycle, the chilled water in the induction unit secondary coil compensates for all the internal cooling load in the space, the refrigerating machines have to be operated throughout the entire summer cycle.

In the modern office building, the use of 8 to 10 ft high glass panes in the perimeter and a lighting load of 4 to 6 watts per sq ft of floor area are not very unusual. In such applications, the changeover point is normally below the outdoor freezing air temperature. Recently, the use of double-coil induction units has also been introduced to provide greater secondary cooling capacity from it. This is done in an effort to reduce the quantity of primary air required for the building. This reduction in the primary air quantity results in further lowering of the changeover point.

It is interesting to note that an induction unit system can operate satisfactorily on the summer cycle without losing temperature control in the space, even when the outdoor air temperature is below the changeover point. This can be accomplished by simply raising the primary air temperature accordingly, to compensate for the transmission loss from the space.

However, it cannot operate on the winter cycle without possibly losing the control when the outdoor air temperature is above the changeover point. This is because, during the winter cycle, the primary air is the only source of cooling and, since its quantity is constant, the cooling available from it is limited. Also, the primary air supply temperature to the induction units cannot be lowered much below, say, 45 F because of practical operating limitations.

Operate on Summer Cycle Most of the Time

To satisfy the occupants, therefore, it is imperative that the system be operated on the summer cycle — at least whenever the outdoor air temperature is above the changeover point. In many installations it may be found that the changeover point is only 10 to 15 F above the outside winter design temperature. In such applications it might even be desirable to operate the system on the summer cycle all year 'round.

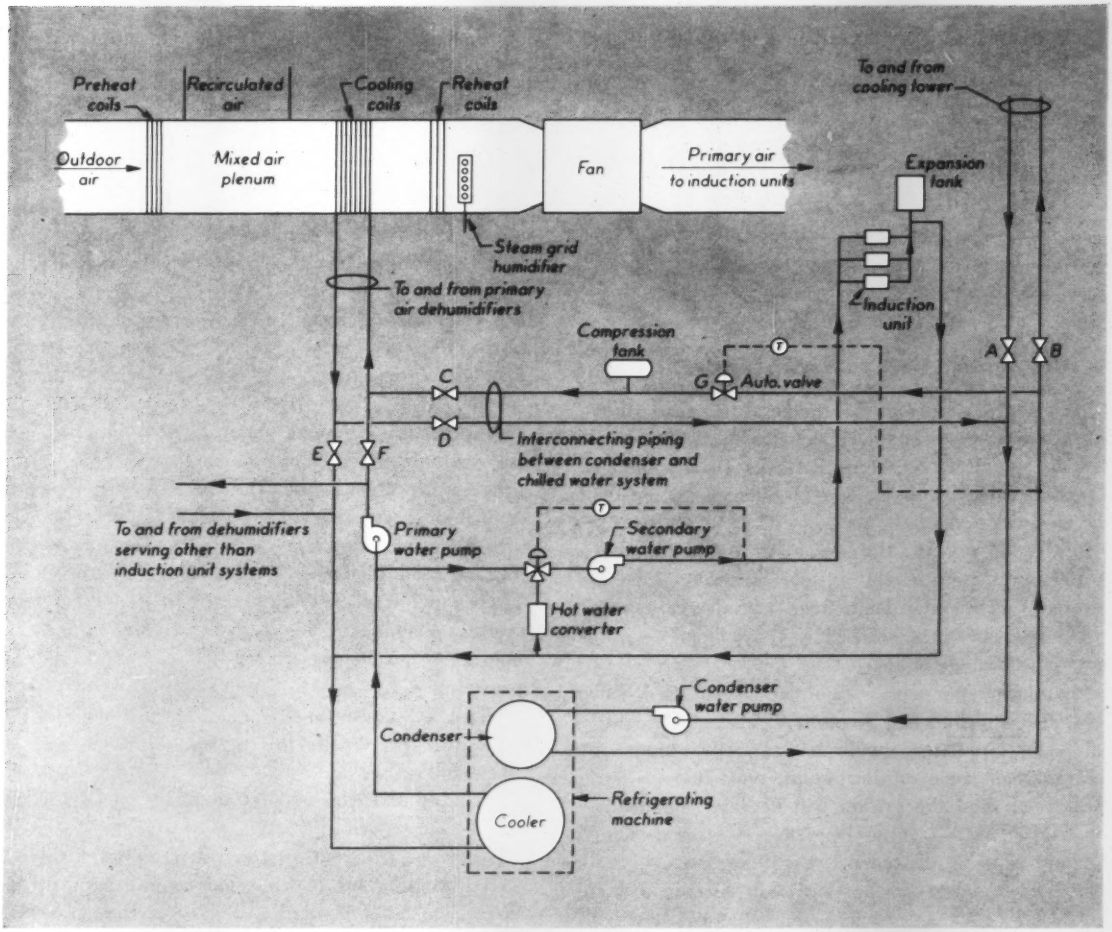
In recent years, people have become more conscious of good air conditioning. They expect individual room control under all operating conditions. This is even more true for modern office buildings. Yet, in practice, many induction unit systems are switched on to the winter cycle when the outdoor air temperature is around 40 to 45 F, even though the changeover point for a particular application may be 10 to 20 F. This is usually done (1) to avoid operating the refrigerating machines below the freezing point because of the cooling tower freeze-up problem, and (2) to save in operating costs. (This, obviously, is accomplished at the expense of comfort control in the space and therefore can hardly be justified for buildings with air conditioning systems of this type.).

Modified System Will Satisfy All Conditions

During marginal weather an induction unit system is quite inefficient if operated on the conventional summer cycle. Also, during freezing weather, means must be provided to remove heat rejected in the condenser — preferably without requiring use of cooling towers.

With some minor modifications, an induction unit system can be operated in such a way that it will provide proper temperature control in the space all year 'round under all possible operating conditions. For the sake of simplicity, we will term this new arrangement as the modified induction unit system.

Fig. 1 shows the modified piping layout. This system will improve, to a certain extent, the operating efficiency of a conventional induction unit system and also eliminate the use of the cooling tower during marginal and cold weather. Hence, it will permit operation of the refrigerating machines below the outdoor freezing weather without any need for winterizing the condenser water system or draining the cooling tower whenever the system is not being used.



1 MODIFIED PIPING LAYOUT will improve operating efficiency of conventional induction unit systems. This system will operate on modified method of operation only during periods when outdoor temperature is between 40 F and changeover point

Referring to Fig. 1, the only supplementary equipment required will be shutoff valves *A* through *F*, control valve *G*, one compression tank, interconnecting piping between the condenser water and the chilled water systems, and some controls. Valves *A* through *F* can be operated automatically if so desired.

Operation Differs Only Under Some Conditions

Operation of the modified system will be different from the conventional induction unit system only when the outdoor air temperature is below 40 F and the system is functioning on the summer cycle. Cooling coils in the primary air handling system provide for the dehumidification required in the space during the summer season.

When the outdoor air temperature is below 45 F, dehumidification is not necessary because of the lower moisture content in the outdoor air. At such times in a conventional system, the cooling coils remain idle and are sometimes drained to avoid any danger of their freezing up.

In the modified system, warm condenser water will be circulated through the cooling coils whenever the outdoor air temperature is below 40 F. It will then provide for some of the reheat required for the primary air and will remove all the heat rejected in the condenser of the refrigerating system, thus making the operation of the cooling tower unnecessary.

Almost all the controls used for a conventional induction unit system will remain the same. The following supplementary control should be provided when the outdoor air temperature drops below 40 F:

1) Close valves *A*, *B*, *E*, and *F*.

2) Open valves *C* and *D*.

3) Valve *G* should be modulated by a thermostat to control the temperature of the water leaving the condenser at about 105 F. This thermostat can be

remotely reset by a master controller to vary the water temperature in accordance with the outdoor air temperature.

4) The primary water pump can be shut down.

5) If a sprayed coil dehumidifier is used, its sprays should be turned off to keep from overhumidifying the space.

6) The cooling coils should run wild. If a modulating type chilled water control is provided on the coils, it should be made inoperative and the valve on the coils should be kept wide open.

At 40 F, Switch Back to Normal Operation

When the outdoor air temperature rises above 40 F, the system should be switched back to conventional operation by closing valves *C* and *D* and opening valves *A*, *B*, *E*, and *F*. Valve *G* should then be made inoperative.

Valve *G* will throttle the quantity of condenser water circulated in the system, depending on the decrease in cooling load. This will decrease somewhat the power consumed by the condenser water pumps at the partial loads.

If multiple condenser water pumps are used, valve *G* and its controls can be omitted. Then, the quantity of water circulated should be manually reduced by shutting off some of the pumps. Note that no harm will occur and the system will operate satisfactorily if the quantity of the condenser water circulated at any time is not reduced by shutting off some of the pumps. Interestingly, there will be only a negligible lag in the system and, consequently, it will be possible to change the operation of the system from conventional to the modified and vice versa almost instantly.

Improves Operating Efficiency

This analysis is based on the assumption that the induction unit system will be operated to provide proper temperature control in the space under all the possible operating conditions. Thus, it is assumed that the system will be operated on the summer cycle — at least as long as the outdoor air temperature is above the changeover point.

It is interesting to note that in an induction unit system the two sources of energy, i.e., primary air and the secondary water, function independently of each other during the summer cycle. Hence, during the marginal weather, it is not possible to nullify the effect of transmission loss from the space against at least some of the internal cooling load in the space and vice versa. This is, however, sometimes improved upon to a certain extent by proper zoning of the primary air according to the building exposure and by scheduling the temperature of the primary air by a solar compensator rather than by an outdoor dry bulb thermostat. However, this alternate method generally will require considerably greater initial investment and also has very limited applications.

As stated before, the modified system will affect the performance of a conventional induction unit system only when the outdoor air temperature is below 40 F and the system is operating on the summer cycle. During such periods, the primary air will compensate for all the ventilation as well as the transmission loss from the space. The refrigerating machine will supply chilled water to the induction units to compensate for all the internal cooling load in the space, such as due to solar load, lighting, people, etc.

The modified system therefore does not change the amount of total thermal energy required for the space at any time in the way of heating and cooling. It will, however, provide a way to usefully employ simultaneously the heat rejected in the condenser and the cooling effect from the refrigerating machine. The overall coefficient of performance of the refrigerating machine is therefore much higher and the operating efficiency of the system will be improved.

With a conventional induction unit system the operating cost during this period will be comprised of the following:

1) Cost of steam generation for providing reheat to the primary air

2) Cost of operating the refrigerating machines to compensate for the internal cooling load in the space.

With the modified induction unit system, the cost of operating the refrigerating machines will be equal, since the total cooling load in each case remains the same. However, the steam consumption will be less because the heat rejected in the condenser will provide for some of the reheat required for the primary air. Therefore the savings with the modified system will be equal to the cost of generating heating effect equivalent to the heat rejected in the condenser at any time.

It is an established fact that, in much of the United States, the cost of heat pump operation compares equally or favorably to other methods of generating the equivalent amount of heat. Therefore, the cost of generating heating effect equivalent to the heat rejected in the condenser will be about equal to the cost of operating the refrigerating machine. Hence, it can be concluded that with the modified system the savings will be equal to the cost of operating the refrigerating machine during this period. Consequently, it will improve the overall operating efficiency of the entire system.

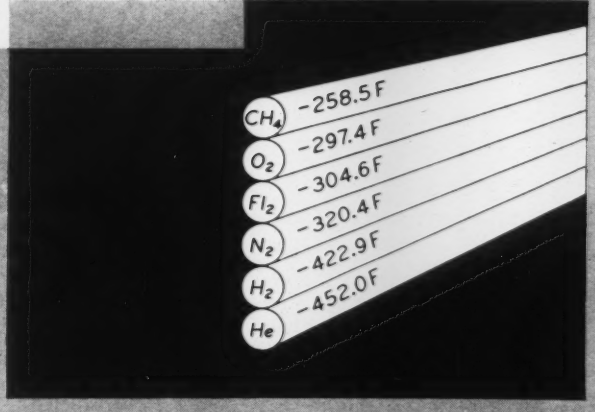
Another article on this subject by Mr. Gupta will appear in an early issue. ⊣

HPAC ENGINEERING DATA FILE

Cryogenic Piping System Design and Installation

- *Fluid flow principles*
- *Selection of pumping equipment*
- *Heat exchanger design*
- *Instrumenting the system*
- *Fabrication of piping*
- *Safety in handling liquids*

By Robert B. Jacobs



Cryogenic piping systems must be designed to operate through a temperature range from room temperature down almost to absolute zero or −459.6 F. Basic design considerations are the same as those for other fluids, but the designer must be aware of differences in the properties of materials, and differences in emphasis and orders of magnitudes in the specifications due to the temperature range. How these low temperatures affect the fluid-mechanical design, selection of pumping equipment, heat exchanger design, piping system instrumentation, and the fabrication and installation of the piping system are presented herein. Precautions to be observed for safe handling of liquefied gases are also given.

The author — R. B. Jacobs — is chief of the Cryogenic Equipment Section, National Bureau of Standards, Boulder, Colorado. He earned a PhD in applied science at Harvard University, and an MS in mechanical engineering at the Massachusetts Institute of Technology where he also taught in the mechanical engineering department and did research in cryogenic engineering. His undergraduate study was in mechanical engineering at the University of California. Dr. Jacobs has been concerned with problems of handling, storage, and transportation of liquefied gases since beginning at the National Bureau of Standards in 1951. His work includes research on two-phase fluid flow, pumping and cavitation, boiling heat transfer, flow measurement, pressurization and stratification, insulation, and equipment optimization.

In the February HPAC Engineering Data File on cryogenic piping system design, Dr. Jacobs discussed the properties of materials at low temperature and the characteristics of the various insulations used in piping systems for liquefied gases.

How Low Temperatures Encountered Affect Design, Installation, and Operation of Cryogenic Piping Systems

PIPING SYSTEMS have been used for many years to transport liquefied gases. Due to the relatively limited demand for such systems, suppliers of the liquids were able to engineer, install, and operate most of those in operation. As a result, relatively few people associated with the piping industry have been called upon to work in this area. The tremendous demand for liquefied gases as rocket propellants and the increasing usage of them in low temperature industrial processes has created a need for a large number of designers, fabricators, and operators of cryogenic piping systems.

Many of the fundamental considerations in piping system design apply to systems for transporting liquefied gases. However, because of the temperature range involved, some aspects of cryogenic piping systems differ from usual considerations. In this report, attention is given to areas in which unique information, data, or techniques are encountered. Included herein are the affects of low temperatures on fluid flow, pumping equipment, instrumentation, and fabrication and installation of the piping system. In the February HPAC Engineering Data File, the affect of cryogenic temperatures on properties of materials and the kinds of insulation used were presented.

Fluid Flow Considerations

The fluid-mechancial design of piping systems for liquefied gases does not require the use of new principles. However, some concepts should be stressed and some particular problem areas should be pointed out.

Systems which involve single-phase (liquid or vapor) flow and systems which involve two-phase (liquid and vapor) flow are encountered. Although not always possible to attain, single-phase (liquid) flow is generally desirable as pressure drops, equipment size, and costs can be smaller, design computations are simpler and more accurate, flow measurement is easier, undesirable compressibility effects (such as choking) are reduced, etc. Single-phase flow of liquid can be achieved by assuring that the static pressure is always greater than the vapor pressure. A fairly thorough discussion of the problems encountered in the single-phase flow of liquefied gases is given by Jacobs.[12]

Two-phase Flow Analysis

The design procedures for systems involving two-phase flow are still relatively crude and inaccurate. Although the results of computations based upon it may have an error of more than 50 percent, the most widely used empirical correlation of two-phase flow data is that of Lockhart and Martinelli.[31] This correlation is based upon data obtained for isothermal, two-component systems with no mass transfer between the phases. It has been shown, however, that the correlation can be used with single-component systems, with appreciable vaporization, if a simple correction is made to account for the variation in the axial component of momentum.[32,33,34]

[32]Numerals refer to references listed on page 156.

Harvey and Foust[35] set up a system of equations for one-dimensional flow of two-phase, single-component fluids utilizing the correlation of Lockhart and Martinelli to account for the frictional pressure drop. However, as the labor connected with numerical computation is very great and as the errors inherent in the equations may be large (due to shortcomings of the Lockhart and Martinelli correlation), design calculations based upon the simple momentum correction[34] may be preferred. A feeling for the complexity of the method of Harvey and Foust can be obtained from Rogers' calculations[36] for the two-phase flow of hydrogen. Rogers' results have not been experimentally verified.

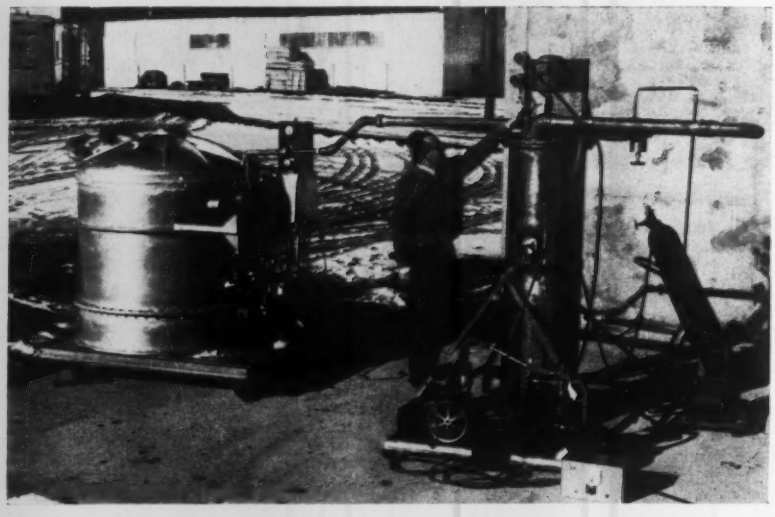
The extreme complexity of the two-phase flow problem has prevented appreciable progress through more theoretical approaches. Although the work of Linning[37] is less empirical than the preceding references, numerical calculation depends upon an appreciable amount of experimental information. Theoretical work on annular-type, two-phase flow is being pursued here and abroad, but results have not yet been published.

Consider Transients in Cooldown

The flow problem encountered in piping systems for liquefied gases about which least is quantitatively known is that concerned with the transient phenomena that occur when systems are cooled from ambient temperature down to operating conditions. These phenomena are not, of course, confined to cryogenics; they occur, for example, when cold water is admitted into a hot pipe. The two questions that have primarily concerned the designer and operator of cryogenic piping systems are: 1) how fast can systems be cooled, and 2) what pressures will occur during cooldown. In many cases, sufficient time is available and the equipment can be sufficiently well designed so that cooldown offers no difficulty. However, if one is not aware of potential pitfalls, he can build a piping system that could never be cooled down. There are systems in which the pipe sizes, valve sizes, etc. are determined by the requirement that the system must be cooled down in a specified time, not by a steady flow rate specification. Design information and procedures related to cooldown phenomena are therefore important to the piping system engineer.

Vent Valves Shorten Cooldown Time

In their detailed aspects, cooldown problems involve simultaneous consideration of the unsteady flow of liquids, two-phase fluids, and vapors. As the critical velocities of two-phase fluids are extremely low, compressibility effects are most important; frequently, cooldown difficulties are due to flow limitations caused by



LIQUID HYDROGEN PUMP immersed in a vacuum-insulated sump is shown here under test. In this case, pump motor is located outside of cryogenic medium but motors can be designed to run submerged in liquefied gas

choking. Because rapid vaporization occurs when the liquefied gas contacts a relatively warm wall, there can be large pressure surges during cooldown. Adequate prediction of the peak pressures is much more difficult than prediction of cooldown time. A common technique for decreasing the cooldown time of relatively long piping systems is to provide vent valves at intervals through which the large amounts of vapor can be bypassed, thereby eliminating the necessity of having to push large volumes through the whole system.

Cooldown Phenomena Under Study

Apparently all of the investigations to date that have been concerned with the cooldown of piping systems for liquefied gases have been oriented toward the prediction of cooldown time. Only the work of Burke,[38] et al, appears in the open literature. It reports reasonable correlation between theoretical predictions and experimental results for piping systems in which the flow is controlled by a choking orifice near the exit. The experiments were carried out with liquid oxygen. Macinko[39] has developed a method for predicting the cooldown time for piping systems without flow-limiting restrictions. That is, the flow rate is determined either by the available pressure drop or by choking. Macinko has obtained good agreement between his predicted cooldown times and those actually measured with both hydrogen and nitrogen. Experimental investigation of cooldown phenomena occurring in actual systems and theoretical analyses of very complete mathematical models are being undertaken.

Selecting the Pumping Equipment

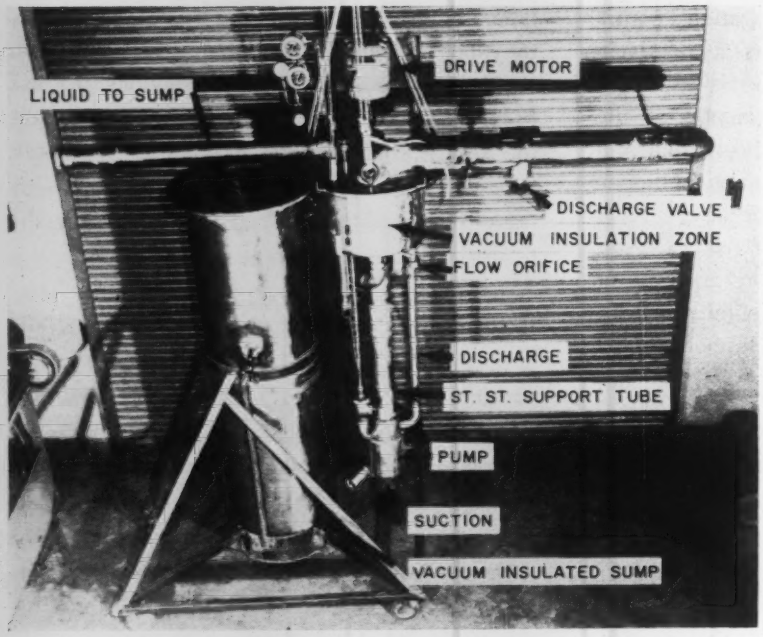
There is a wide range of specifications for pumping equipment used in piping systems for liquefied gases. Although the most severe specifications are usually associated with space-borne equipment, they should be of interest to the earthbound piping engineer because of his interest in ground-handling systems, test facilities, etc. that are associated with space-borne equipment. We can therefore say that our interest lies in the entire range of heads up to 50,000 feet and in the entire range of capacity up to more than 10,000 gpm. Furthermore, as any value in the head range can be associated with any value in the capacity range, it is apparent that positive displacement, centrifugal, and axial pumps have their places. For the higher heads and capacities, high shaft speeds are required, and compressibility effects, especially with hydrogen and helium, are appreciable.

Fundamental Design Concepts Apply

It should be stressed that the fundamental concepts and methods, which are adequate for the fluid-mechancial design of pumps for common fluids, are applicable to liquefied gases. The performance characteristics will differ because of such things as greater leakage due to lower viscosity. The efficiency may be lower due to the fact that a less dense fluid requires less total power input while the so-called fixed losses (such as those occurring in bearings) will not decrease appreciably. These differences in characteristics have been noticed when water pumps have been tested with hydrogen and nitrogen.[40]

Cavitation Related to Fluid Properties

The common methods for predicting cavitation characteristics associate these characteristics solely with the pump and conclude that pump characteristics depend upon the fluid being pumped. Recent work[40,41,42,43] indicates that perhaps a more useful point of view is that it is the cavitation characteristics of the fluid which change. The commonly used cavitation parameters differ because of differences in the thermodynamic and transport properties of the fluids, not because the pump behaves differently. It seems probable that when the "proper" cavitation parameters, derived from fundamental considerations, are used, cavitation characteristics



LIQUID HYDROGEN PUMP and test facility piping are shown here. Pump supported by a stainless steel tube is immersed in vacuum-insulated sump and is driven by the electric motor through an extended shaft. Pump has rating of 110 gpm at a head of 163 ft (5 psi) and has a NPSH requirement of 0.21 ft or 2.5 inches

will be as accurately predictable as performance characteristics.

Centrifugal Pumps Widely Used

The centrifugal-type pump has been most widely used with liquefied gases although turbine-type transfer pumps are common. Reciprocating pumps have long been used to compress liquefied gases for the production of high-pressure, room temperature gases. This type of equipment has low capacity but pressures up to 10,000 psia are achieved, and development of equipment for pressures to over 13,000 psia is underway.[44] Some work has been done on vane-type cryogenic pumps, but no results have been published. Work is also progressing on multi-cylinder pumps[45] to provide high pressure gas for purging, pneumatic control, cooling, etc.[46,47]

The work done on the pumping of liquefied gases with centrifugal pumps indicates that, as far as performance characteristics are concerned, no extraordinary behavior is to be expected. The years of industrial experience with liquid oxygen and liquid nitrogen and the years of experience with liquid oxygen ground handling and rocket engine pumps as well as the work of Jacobs,[40] Martin, et al with water, oxygen, nitrogen, and hydrogen, and the work of Cain,[41] et al with hydrogen substantiate this. However, basic studies into cavitation characteristics are urgently needed. Some progress has been made in this area recently by analyzing cavitation characteristics through consideration of the thermodynamic properties of the fluids.[40,41,42,43] For example, it was predicted theoretically and shown experimentally[40] that the minimum required net positive suction head (NPSH) for hydrogen is only about 1/42 that required for nitrogen in the same pump. In a water pump with a specific speed of 1930 rpm $gpm^{1/2}$ $ft^{-3/4}$ at 3450 rpm only 2½ in. NPSH was required to prevent cavitation with hydrogen,[40] while a booster-type centrifugal pump, designed for hydrogen and with a specific speed of about 800 at 12,000 rpm, required an NPSH of only 6 in.[41] The measurement of net positive suction head with adequate accuracy requires vapor-pressure instrumentation.[48]

Besides the low NPSH requirement, pumping hydrogen differs from pumping other liquids in that the low density requires very high heads for high pressures. Where weight and space limitations are severe, the use of high speeds is neces-

sary. One development along this line is the radial-vane pump described by Bosco.[49]

Bearings Are One of Problem Areas

Two problem areas which occur with pumps that have not been mentioned previously concern bearings and seals. The bearing problem is frequently solved by locating the bearings outside the cryogenic medium, and using shafts which are so long that energy dissipation, heat transfer from the atmosphere, or heaters can keep the bearings warm. In these cases, no exceptional bearing problems arise, but the disadvantages of long shafts and the possibility of appreciable heat transfer into the pump are present.

The advantages of submerging the bearings in the liquid that is being pumped have stimulated work along this line. This can be achieved by either submerging the pump in a sump or by bleeding some of the liquid from the pump discharge through the bearings. All of the reported work on submerged bearings has been with thoroughly cleaned and degreased ball bearings. This work indicates that the separator is the critical item in the performance of lightly loaded ball bearings submerged in liquefied gases. Bearings have been evaluated in pumps operating from 3000 rpm up to 22,000 rpm in liquid hydrogen and liquid nitrogen, and in a test rig operating from 3000 rpm to 10,000 rpm in liquid nitrogen.[50] The most successful reported separator material has been fabric-reinforced phenolic. Current tests show that a filled polytetrafluoroethylene material makes a very superior separator; knowledge of the filler material is proprietary information of a manufacturer. Satisfactory performance has been achieved with angular contact bearings with balls and races made of either 52100 steel or 440-C stainless. The stainless is preferable, however, because of its greater resistance to corrosion in the event that water condenses on the bearings. Running times of hundreds of hours have been achieved in tests up to 12,300 rpm. Long lives may also be attainable at higher speeds, but tests have not been run. The tests at 22,000 rpm in hydrogen were terminated after about six hours, but not because of bearing failure.

Small ball bearings have been run successfully in gaseous hydrogen from room temperature down to liquid hydrogen temperature at 10,000 rpm.[51] These bearings had 440 stainless steel balls and races, used micarta ribbon retainers, and ran successfully both with and without oil.

Shaft Seals Also Problem Area

As with bearings, the problems arising from the operation of shaft seals at low temperatures have been circumvented by putting the seals in ambient temperature regions. The author is not aware of any literature on low temperature liquid seals, except for the limited and undetailed comments in References 40 and 49. One reason low temperature shaft seal development has lagged is because sump-type pump configurations need not require cold shaft seals. If the pump is driven by an extension shaft with the driver in the atmosphere, only a room temperature seal to hold the sump pressure is needed. If the driver is in the sump as an integral part of the pumping unit, no seals whatsoever are needed. It has been thoroughly demonstrated that electric motors can be designed for operation submerged in any liquefied gas.[41] There is no apparent reason why submerged turbine drives, using energy from the environment to vaporize some of the liquefied gas to drive the turbine, cannot be developed for the larger power requirements.

Heat Exchanger Design

Although the piping system engineer is not normally concerned with detailed heat transfer considerations, except with respect to insulation problems, some piping systems do contain heat exchangers; a few words concerning heat transfer are therefore in order. Heat transfer considerations in cryogenic equipment involve no new principles. It should be pointed out, how-

ever, that there is a definite lack of heat transfer data directly applicable to liquefied gases and that some of the published results are contradictory. Many convective heat transfer calculations for cryogenic equipment are based upon the accepted correlations derived from data obtained with more common fluids. Of course, when new geometries are used the designer should be most skeptical in extrapolating data. As much heat exchange in cryogenic equipment involves boiling or condensing, this type of information is required. However, most of the information available has been obtained with simple geometries (wires, cylinders, etc)[13,52,53] or with other special geometries,[14] and so is not directly applicable to most heat exchanger designs. Although heat transfer investigations concerned with liquefied gases flowing through actual heat exchanger configurations are in progress, no results have appeared in the open literature.

Cryogenic Instrumentation

The instrumentation with which the piping systems engineer is concerned is related primarily to pressure, temperature, and flow rate. However, because piping systems contain tanks, in which the fluid is essentially at rest, liquid level and static mass measurement are also important. As is generally the case with other cryogenic equipment, cryogenic instrumentation is not significantly different from conventional instrumentation except that the low temperature, and possibly high vacuum, requirements may affect the details of some of the sensing elements.

How Pressures Are Measured

Static or steady-state pressure measurement offers no difficulty in cryogenic equipment. The geometry of the pressure tubing should be such that liquid cannot continuously drain, or percolate into it, and if heat conduction is to be minimized the tubing should be stainless steel. All of the usual procedures such as the use of piezometer rings and prevention of unknown hydrostatic heads should be followed. Of course, all contaminants which can freeze and block the pressure taps and connecting tubing must be removed before cooldown. It is amazing how often inexperienced (and experienced) operators of cryogenic equipment will encounter blockage of small lines due to the freezing of contaminants therein.

Dynamic or unsteady pressure measurement offers no difficulty if the transducer can be located so that its temperature is known. This can usually be accomplished by locating the transducer in the atmosphere and connecting it to the pressure tap with a piece of stainless steel tubing. The only reason it may be inadvisable to do this is that the dynamic response of the system, with the connecting tubing, may be unsatisfactory. There are transducers available which are made and calibrated for use down to about −350 F, and possibly lower. As the zero shift with temperature is quite large, the temperature of the transducer must be known. Thus, transducers can be connected directly to equipment only when the transducer is at a known temperature. However, if pressure transients are to be measured during the cooldown of equipment, a transducer connected directly to the equipment will not yield accurate pressure information directly. The signals, or records, will have to be manipulated to account for an effective transducer temperature at each instant.

What Ways to Measure Temperature

The problems of temperature measurement can also be divided into those associated with static and those associated with dynamic situations. The former can be adequately handled, but better response characteristics are desired for the latter. For a comprehensive exposition of the field of thermometry, the reader is referred to References 54, 55, and 56.

Five types of thermometers are commonly used in cryogenic applications: thermocouples, vapor-pressure bulbs, gas thermometers, platinum resistance thermometers, and semiconductor thermometers. The choice of system depends

upon conventional considerations such as accuracy, sensitivity, complexity of associated circuitry, cost, and dynamic characteristics.

Thermocouples have wide use in cryogenic engineering, their main assets being adequate accuracy, good response time, and moderate cost. A primary disadvantage seems to be a drift in calibration (or instability) caused by thermal cycling. Of course, as is true with all thermometers, the installations must be such that the junctions are adequately tempered; that is, heat conduction through the leads and well to the junction must be made negligible. As the thermoelectric power of thermocouples is smaller at lower temperature (for copper-constantan it is only 3.3 microvolts per degree F at −423.6 F), junctions with higher powers are continually being sought. A junction which has found wide use, and which has a power of 8.3 microvolts per degree F at −423.6 F, is gold with a 2.1 atomic percent cobalt impurity versus copper.[57] Because the instability is believed to be due to the copper, work is now being done by the same investigators on a junction of the gold-cobalt, mentioned above, versus silver with a 0.37 percent gold impurity.

Vapor bulbs have the advantages of extremely high accuracy and simplicity, but have limited ranges. Tests indicate that vapor-bulb systems can have time responses that are about as fast as those of thermocouples made with 30 gauge wire. In equipment where the measured temperature range is between the triple and critical points of a suitable substance, the use of vapor-pressure thermometers should be seriously considered.

Gas thermometers have the serious disadvantages of being difficult to fabricate and difficult to use. They are therefore probably undesirable for use in piping systems for liquefied gases.

Platinum resistance thermometers have the advantages of stability of calibration, accuracy, linearity (down to −423.6 F), and a large temperature range. Their primary disadvantage is cost and procurement time. The author is not aware of any data concerning the response characteristics of platinum resistance thermometers, but they are relatively sluggish.

Semiconductor thermometers are also electrical resistance thermometers, employing materials such as carbon, germanium, silicon, or metallic oxides as the sensing elements. Their advantages include relative simplicity, accuracy, and, in some cases,[58] stability when subjected to thermal cycling. They have the disadvantage of non-linear calibration curves and, in some cases (e.g. carbon), they are unstable. The large changes in the resistance of the units which occur over appreciable temperature ranges require that special consideration be given to the circuitry if the measurements are to be optimized.[59] As these sensors can be made rather small, their response characteristics can be fast.

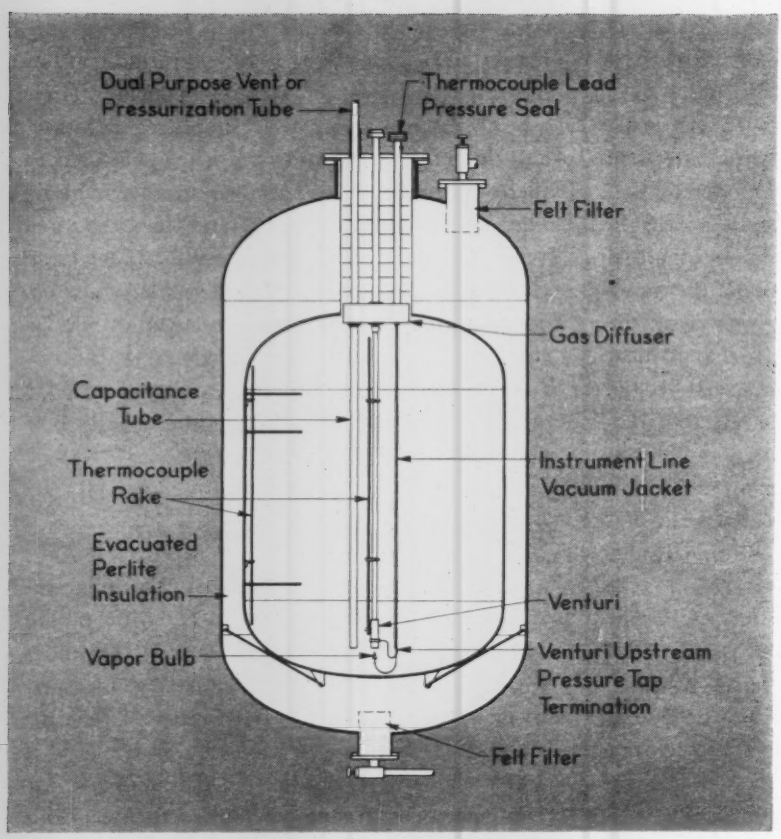
Flow Measurement Most Difficult

Flow measurement is perhaps the major instrumentation problem associated with piping systems for liquefied gases. When one examines the difficulties encountered with flow measurement of liquefied gases, it is apparent that the troubles are not due to the fact that the fluid is a cryogenic liquid, but to basic deficiencies in the equipment and techniques now available in this area. For example, the major difficulties encountered if two-phase flow exists are the same for water or ammonia as for hydrogen or oxygen.

The most desirable flow measuring device would be a mass flow meter. Although some development work on these devices (e.g. momentum and sonic devices) for liquefied gases is apparently underway, no results are yet available. Consequently, all flow measurement of liquefied gases, except for weight difference methods, has been volumetric. As it is usually desirable to know the mass flow rate, the density must also be ascertained. With single-phase fluids this is relatively easy — a pressure and temperature measurement is sufficient. In many systems, the density is sufficiently well known without having to make measurements. The problem of determining the density of a two-phase fluid, however, has not been solved.

Turbine Meters Often Used

Turbine-type meters have been most exten-



LIQUID HYDROGEN test Dewar shows type of instrumentation used in cryogenic piping systems. These include thermocouples and vapor pressure thermometers, capacitance liquid level indicator, and a venturi meter. Inner shell is suspended by stainless steel neck and is given transverse rigidity by stainless steel supports at bottom. Felt filters keep powder insulation (perlite in this case) out of vacuum pumps

sively used. Their main advantage is that they are essentially true volumetric meters. Whereas meters which utilize the Bernoulli effect, such as orifice and venturi meters, require a knowledge of the fluid density in order to obtain a flow measurement from the meter output (pressure difference reading), volumetric flow measurement from turbine-type meters can be obtained from the meter output alone. As mentioned above, in many systems the fluid density is known accurately enough without having to measure it; therefore, its requirement for Bernoulli-effect meters is not a liability.

Vapor May Cause Rotor Overspeeding

There is, however, a serious disadvantage to turbine-type meters as now used in many piping systems for liquefied gases. The meters are usually sized to handle the steady-state flow rate of liquefied gas. Consequently, when the large volumes of vapor, which are formed during cool-down of the system, are forced through the meter, terrific overspeeding of the rotor occurs and meters can be damaged through failure of the rotor or bearings. On the other hand, it should be stressed that there is ample evidence to indicate that turbine-type meters are reliable for use with liquefied gases if they are not abused.

Water Calibration May Be Adequate

In the past, turbine-type meters used for liquefied gases have been calibrated by the manufacturer with water only. As the customer normally does not have facilities to calibrate the meters in liquefied gases, it has been assumed that the water calibration is adequate for use with liquefied gases. Recent information indicates that this is, in fact, the case for at least one meter.[60] This was a 1½ in. turbine-type meter with ball bearings, in which the balls and races are type 440 stainless steel. The meter is installed in a

submerged configuration for a liquid hydrogen application; it is, therefore, not subjected to the overspeeding abuse mentioned above. After this meter was operated for about 300 hours in liquid hydrogen, it was sent to the manufacturer for recalibration with water. This calibration agreed with the manufacturer's initial water calibration to within 0.5 percent. The meter has subsequently been calibrated with liquid hydrogen from about 20 percent to about 80 percent of its range. This hydrogen calibration curve is within 1 percent of the second water calibration curve.

Other Common Flow Meters Used Too

Orifices, venturis, and nozzles have been used in the past for measuring the flow of liquefied gases; however, detailed evaluation of these devices has been undertaken only recently. Based upon work with hydrogen, nitrogen, and water, Richards[61] concludes that sharp-edged orifices are reliable flow measuring devices for use with liquefied gases. His results were reliable except when two-phase flow was known to enter the orifice. In addition he found that, although the static pressure downstream of the orifices was as much as 10 in. Hg below the vapor pressure (he could not reduce the pressure any lower than this), the orifice indications were reliable. With field type instrumentation, Purcell[62] has used a venturi to measure liquid hydrogen flow rates with less than 1 percent error.

The state of the flow measurement problem with liquefied gases is not yet such that any one type of meter can be recommended over another type. There are groups who have obtained satisfactory results with turbine-type meters but not with orifices and venturis. On the other hand, some people are satisfied with the performance of orifices and venturis, but have not obtained satisfactory performance with turbine-type meters.

Two-Phase Flow Hard to Meter

The primary difficulty in flow measurement is encountered if two-phase flow exists. This problem is, of course, an extension of the problem associated with density determination. This situation, which is common to all volumetric flow meters, will disappear when a mass flow meter is developed, but until then the development of an instrument to determine the liquid-vapor composition of a flowing fluid is needed. There are several programs underway which aim to perfect equipment for detecting[63] the presence of vapor in liquid, but the adequacy of the instruments so far developed, for the quantitative measurement of the composition of two-phase flows, is questionable.

In installations where the static pressure upstream of a flow meter may inadvertently approach the vapor pressure, thus creating the possibility that two-phase flow may enter the meter, a device should be installed to indicate this. The simplest reliable device known to the author is a vapor-pressure bulb as described by Richards.[61]

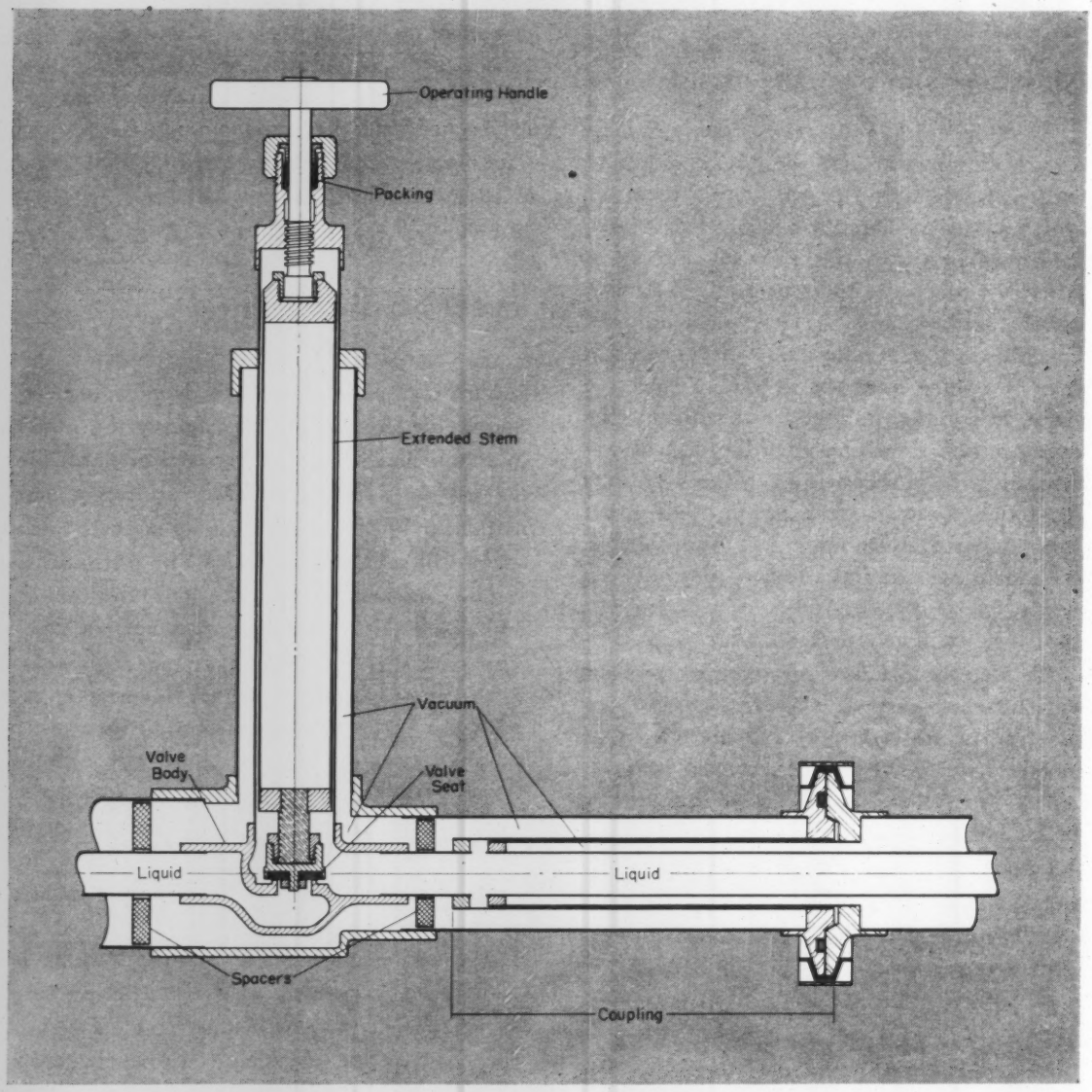
Measuring Tank Contents

Another type of instrumentation that is important in handling liquefied gases is that required for determining the amount of liquid in a tank. Several adequate systems are available for use with ground handling equipment, but attainment of the desired accuracy in uninsulated tanks still presents problems. The instruments can be classified as direct weighing, hydrostatic, and liquid level. The direct weighing of cryogenic tanks is no different from other tanks. Load cells using strain gauges, inductance, capacitance, or resistance principles, or some other sensing device can be used along with conventional circuitry. However, with the less dense liquids (i. e. hydrogen and helium) the accuracy of direct weighing systems decreases because of the small ratio of liquid weight to tank weight.

The use of hydrostatic pressure systems is widespread. Depending upon what the pressure signal is to be used for, either electrical or mechanical sensors, recorders, etc may be used. The location of the pressure taps, and their layout, is important. In many installations the taps have been placed in the vent and liquid

lines; consequently, when there is liquid or vapor flow, the instrumentation cannot be used. The system must be such that the location of the liquid-vapor interface in the pressure lines is known. In some systems, the high-pressure tap has been taken directly from the bottom of the tank, permitting percolation; this produces a disturbance in the signal. In a relatively well-insulated tank, the mass of liquid can be obtained from a hydrostatic system if the tank geometry is known. However, if there are appreciable convection currents, there may be appreciable error in a mass determination.

Liquid level devices are widely used for control and indication of tank contents. As these are simply height-measuring devices, information concerning tank geometry as well as fluid density must be known if fluid volumes and masses are to be determined. The capacitance liquid level device[64] has been used successfully for



STEM AND BODY of ordinary valves can be extended with stainless steel tubes as shown here to make them suitable for cryogenic piping systems. This scheme keeps packing and actuators at ambient temperature. The same type of valve is commonly used in ground handling systems regardless of insulation used but one shown is vacuum-insulated. Bayonet coupling is designed to keep O-ring packing at ambient temperature too

many years for the indication, control, and recording of the liquid level of liquefied gases. It is a continuously indicating device and has a fast response. For point (and multipoint) indication, control, and recording, the carbon resistor liquid level device has been successfully used for years. As the properties of carbon resistors drift under thermal cycling, the associated circuitry should be made relatively insensitive to this. With proper circuit design, the carbon-resistor level indicator can respond in 2 to 3 seconds. Some work has also been done on ultrasonic type indicators, vibrating paddle type indicators, and radiation-type indicators.

How to Fabricate, Install Piping

The techniques used for fabricating and installing piping systems for liquefied gases are the same as those used for the more familiar systems. Shielded arc welding, silver soldering, and sometimes even soft soldering are used for joining. Unfortunately, the work done on the mechanical properties of weldments at low temperatures is very limited. Mikesell and Reed[4] report tensile and impact work on welded 5086 aluminum down to −423.6 F. Mikesell[65] has obtained impact data on 304L stainless steel welded with type 308 rod at −324.6 F and −423.6 F. Tensile data are also available on low temperature weldments of types 347 and 302 stainless steels,[66] and on type 316 stainless steel.[67] Perhaps the only difference between fabrication techniques for piping systems for liquefied gases and those for other systems occurs when a vacuum-type insulation is used on the former. In this case, the fabricator must be fully aware of the extreme attention which must be paid to cleanliness, cleanup, and leak tightness. It is recommended that the tightness be verified by means of a mass spectrometer leak detector.

Select Gaskets for Low Temperatures

There is apparently no published information which evaluates the possible schemes for gasketing flanges which are exposed to liquefied gases. However, in many installations commercial impregnated asbestos gasket materials have been used with apparent success. As many gasketing materials have greater coefficients of expansion than the flange and bolt materials, there is a tendency for the load on the gasket material to be relieved when a flange is cooled down. This tendency can be counteracted by providing components, such as springs or spring washers, which will take up the relative motion and still keep the gasket loaded. As would be expected because of their large thermal expansion coefficients, O-rings made of elastomeric materials have usually proved unsatisfactory as low temperature seals. Recent work indicates elastomeric O-rings which are tremendously loaded make satisfactory low temperature seals. Successful use of gas-filled metallic O-rings has been reported, and plastic (e. g.) polytetrafluoroethylene) coated gas-filled metallic O-rings show promise. Normally, in dismountable vacuum insulated equipment, the couplings are designed so that the seal is made at room temperature; elastomeric O-rings are a common seal in these cases.

Avoid Penetration of Insulation

The mounting and hanging of piping systems for liquefied gases should pose no extraordinary problems. The outer jacket of vacuum insulated lines should have sufficient ruggedness so that the methods commonly used for uncovered pipes can be used. With conventional insulations, it is best if mounting and hanging structures do not enter the insulation. This eliminates heat leak through these structures and eliminates the problem of sealing the vapor barrier around the structures. However, if it is necessary to attach these structures to the pipe, stainless steel or nonmetallic materials of minimal cross-sectional area should be used to minimize heat conduction through supporting members. In all systems, and especially uninsulated and poorly in-

sulated systems, care should be taken to assure that ice does not accumulate on expansion joints, rollers, etc, making them inoperable.

Fittings, such as ells and tees, offer no difficulty with uninsulated or conventionally insulated piping systems. With vacuum-insulated systems however, there are design and fabrication problems. This should be immediately apparent when one realizes that there is usually a fitting in both the liquid line and the jacket. If commercial fittings are sized so that the smaller fits into the larger, some of the welds on the inside line will be difficult to make, clean, and repair. Also, the size of the outside fitting may have to be larger than necessary for thermal considerations in order to allow assembly. Fittings which are split axially are commercially available. If such fittings are used on the vacuum jacket, an appreciable part, if not all, of the liquid line — the inside line — can be fabricated and tested before the jacket need be installed. Vacuum insulated ells can be made from flexible sections of line; however, this is not the most economical way to solve the problem.

Ordinary Valves Can Be Adapted

The problems arising in connection with valves for liquefied gases stem from the same situations which have been considered above, such as differential contraction, heat leak, distortion due to temperature gradients, freezing of packing, icing together of parts which must have relative motion, and seat tightness. Adequate solutions to these problems depend upon the application, but some general remarks can be made.

It is quite satisfactory for many applications, regardless of the insulation used, to adapt ordinary valves for low temperature use by: 1) extending the stem and body with stainless steel tubes so as to keep the packing at essentially ambient temperatures, and 2) changing the seat materials, if necessary. This is probably the most widely used scheme for ground handling. It appears that a primary problem with valves in sizes larger than 3 in. is tightness across the seat. The reasons for this have not been ascertained. Besides the simplicity and economy associated with the use of extended-stem valves, an advantage is that ordinary actuators can be used because they are at ambient temperatures. As the stem packing in these valves communicates directly with the liquefied gas, the extension should be designed and the valve should be installed so that liquid will not drip into the extension region causing a large heat leak, freezing the packing, and icing the moving parts.

There are other valve configurations which are less widely used and have certain special advantages. For example, in certain vacuum insulated valves, the heat leak due to metallic conduction is reduced to zero and the presence of the valve merely requires a slight increase in diameter of the pipe line. These valves can be actuated either pneumatically (with helium), manually, or electrically. Some of these valves require no packing because they have no stems. An example of this type of valve is given by Richards.[68]

Safety Considerations in Cryogenics

The major hazard common to all liquefied gases is that they will all freeze flesh, causing serious injury to personnel. It is obvious that direct contact with the liquid or cold vapor is to be avoided. Not so obvious is the possibility that gloves and other protective clothing can become frozen and difficult to remove. The person can become more seriously frozen than if such clothing had not been worn. There is also the possibility that the venting system of a storage container may become inoperative due to inadvertent valve closure, the malfunctioning of relief valves or formation of a plug of solid water or air. In such cases, there is danger of bursting the container.

Other safety considerations are essentially the same as those associated with more common substances. When handling an oxidant such as oxygen or fluorine, it is necessary to avoid contact with a material or substance that will re-

act too readily. What is meant by "too readily" must, of course, be determined for each application. When handling a reducing agent such as hydrogen, contact with oxidants should be avoided.

Of the common liquefied gases, helium and nitrogen are inert so safety problems associated with chemical reaction are not cause for concern. At high temperatures nitrogen does react directly with some metals — magnesium, for example.

In the oxidant category, fluorine and oxygen must be considered. Because of its extreme activity with essentially all materials, the handling of fluorine presents very severe problems with equipment as well as personnel. Although liquid fluorine has been handled for several years, the material problems and handling techniques are still far from solved.

Safety With Oxygen Essential

The large scale use of liquid oxygen for many years has stimulated a great deal of thought in the area of safety. As most materials (cloth, wood, steel, asphalt paving, valve packing, gasketing, etc.) burn very rapidly in oxygen, a great deal of care is necessary in the design, maintenance, and operation of piping systems for liquid oxygen. The types of situations which may arise are illustrated by the following examples:

1) An operator, who was transferring liquid oxygen through a leaky transfer system, saturated his clothes with oxygen. As he was lighting a cigarette after the operation his clothes ignited explosively.

2) During a transfer operation on asphalt-type paving, a leaky connection allowed liquid oxygen to permeate a substantial area of paving. When the operator inadvertently dropped a wrench, the paving ignited and burned explosively.

3) When preparing to purge a transfer system with oxygen, high pressure gas was rapidly introduced into a pipe against a closed valve. The system ignited and burned some of the stainless steel system. It is thought that the ignition temperature in this case was created by the compression at the valve. Whether or not there was a combustible material in the valve to start the fire is not known.

4) In one case it appears that the high temperatures caused by an oversped turbine-type flow meter ignited a system.

5) In another case, piping started to burn and the fire was not extinguished until two rather large steel liquid oxygen transport containers were completely burned.

The above examples are ample proof that safety with liquid oxygen must be a primary consideration. All substances which may be incompatible with oxygen must be absent. For this reason, special techniques for cleaning oxygen equipment have been developed. In order to be able to design, maintain, and operate piping systems for liquid oxygen, those involved must know what materials can be used, and what materials must not be used. Examples of the type of work done in this area are references 69 and 70.

Rid Hydrogen Piping of Oxygen

The safety considerations pertinent to liquid hydrogen, liquid methane, etc. are the same as those for all "combustible" liquids and gases. The purpose is to prevent the mixing of an oxidant (usually atmospheric oxygen) with the substance in sufficient quantities to form a combustible mixture, and further, to prevent the ignition of such a mixture should it be formed. An additional factor with liquid hydrogen is the possibility that air will condense in the liquid, building up an amount of solid oxygen which can violently combine with the hydrogen. Normal practice has been to purge piping systems for liquefied combustible gases with an inert gas before introducing the liquefied gas. This is done either by a "sweeping" purge or by an evacuation and purge procedure. The latter procedure is more reliable because of the smaller possibility that parts of the system will be bypassed by the purge gas. Design, operation, and maintenance personnel concerned with piping systems for liquefied gases should acquaint themselves with the general information in this area pertaining to common fluids such as gaso-

line, propane, natural gas, etc. Reference 71 gives some information pertinent to both gaseous and liquid hydrogen.

Cryogenics Embraces Many Fields

The point to be emphasized is that cryogenic engineering is a synthesis of the older branches of engineering (mechanical, chemical, electrical), and therefore involves no new basic principles. The discussion presented here has avoided those areas where usual engineering experience is directly applicable. An attempt has been made to discuss situations where the unwary may go astray and where the cryogenic engineer has evolved new techniques. In addition, an attempt has been made to indicate the location of data and information applicable to new materials and situations, as well as that applicable to the familiar materials and situations in low temperature regions. Finally, it is suggested that those interested in obtaining a comprehensive orientation in the field of Cryogenic Engineering refer to Scott's book[56] on Cryogenic Engineering.

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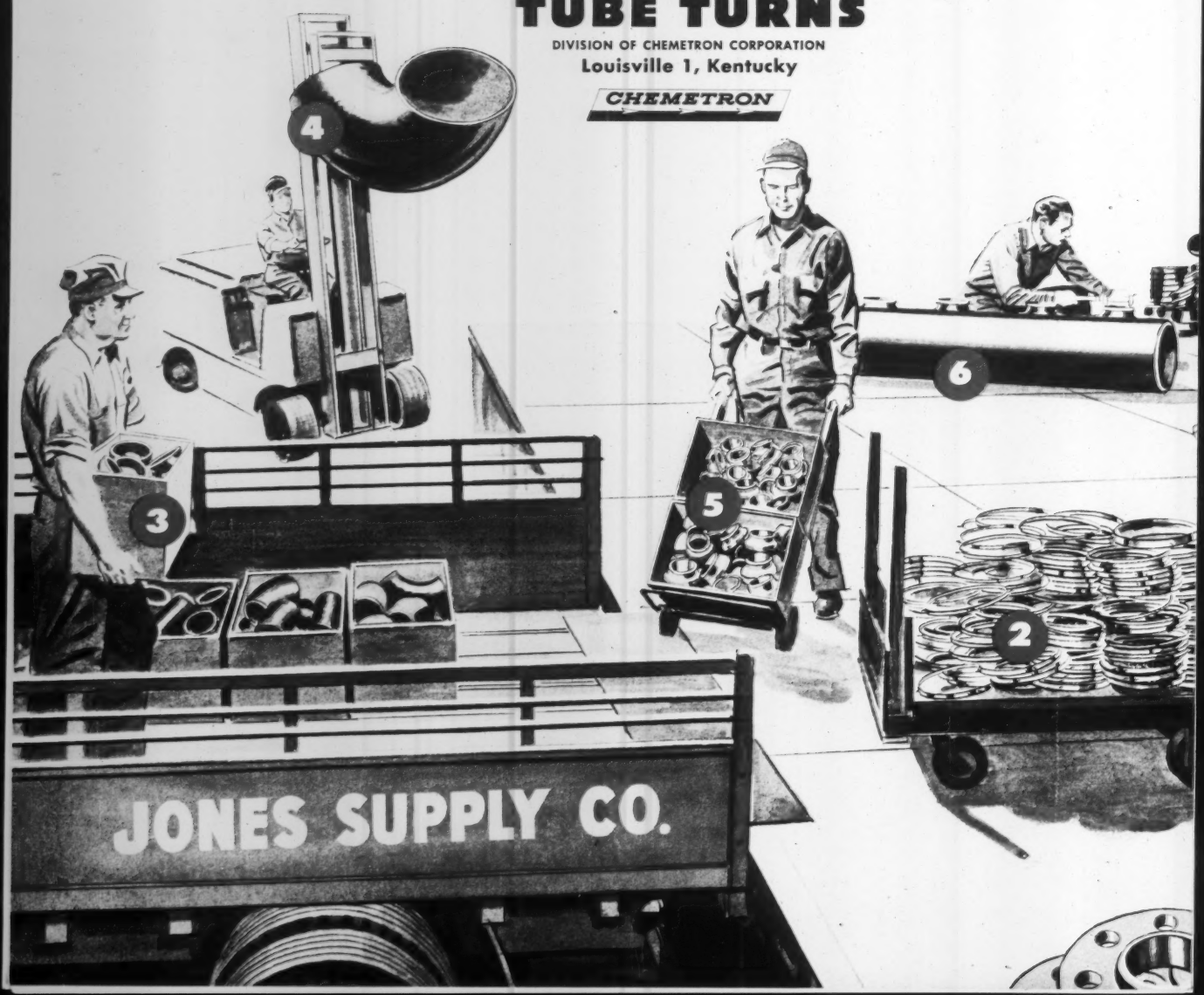

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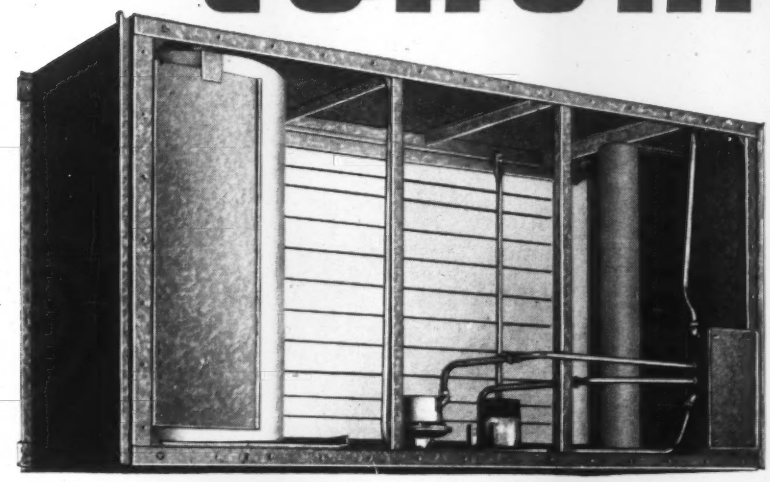
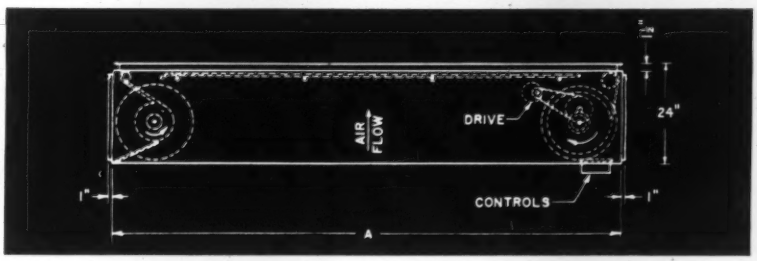
MORE!

To avoid space problems, air engineers specify

CONOMATICS



HORIZONTAL CONOMATIC



MOST COMPACT

Because, with Continental's advanced design, the exposed side of the media unrolls to become the *face* of the filter—both media rolls are mounted in the air stream, within the dimensions of the duct or plenum, without reducing the effective face of the filter. No extensions or projections are necessary.

That's why Conomatic *requires the least possible over-all length and width for a given specification of CFM.*

MOST TROUBLE-FREE

Simple controls—either timed-interval or pressure-operated—assure positive curtain movement in the Conomatic. Simplicity of design reduces moving parts to a minimum.

Since the metering device and the operating controls are completely independent of the variable diameter of the take-up spool, Conomatic eliminates the frequently troublesome variable-speed clutch. Its direct chain drive is further assurance of positive curtain movement.

Automatic cut-off of drive mechanism when end of media is reached, and reload warning signal, protect against run-out. Galvanized construction throughout.

75 SIZES AND SHAPES TO JUST FIT ANY NEED

Whatever the CFM requirement, if it's a job for a "horizontal" air filter, there is a Conomatic sized just right to fit it. And since Conomatic needs up to 45% less length and width for a given capacity, it offers important savings in space and convenience.

CHOICE OF ACCESS ARRANGEMENTS

To suit the installation, Conomatic offers complete choice of access for loading and unloading media. *Either or both* can be provided from side or front.

CHOICE OF DIRECTIONS

If desired, Conomatic can be installed in a vertical duct to filter upward moving air.

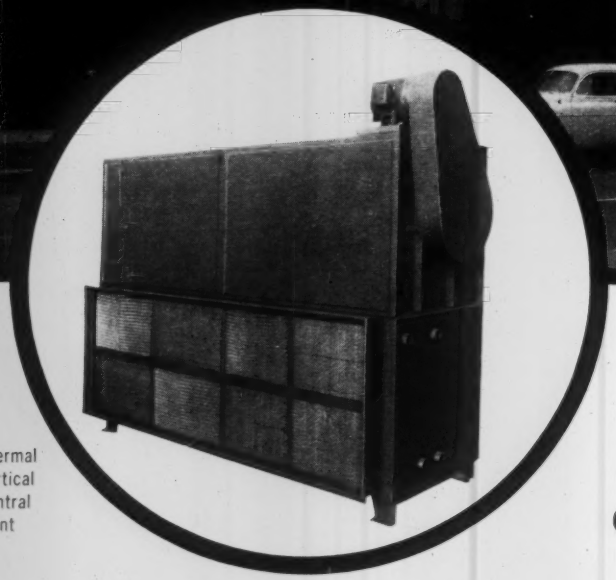
PRE-WIRED, READY TO INSTALL

Conomatic arrives on the job site fully assembled and completely factory-wired—ready to be put in position. Make the power supply connection and the Conomatic is ready for loading and operation.

Ask your nearest Continental Representative for Bulletin No. 822, or write direct.

Engineers, Architects, Contractors, and Owners are happier when **CONTINENTAL Clears the Air.**

Consulting Engineers: Lockwood, Andrews and Newnam, Houston
Thermal Agent: McMillan Equipment Co., Houston



Thermal Vertical Central Plant

20 THERMAL Central Plant Units Air-Condition Houston Library

The Julia Ideson Building of the Houston Public Library was recently remodeled to include air conditioning. Here, again, Thermal equipment is providing the big difference in comfort for citizens reading for work or recreation.

The rapidly increasing number of buildings throughout the country using Thermal Engineering's air conditioning and ventilating equipment is recognition by architects, engineers and owners of its quality and service.

The Thermal line of finer equipment includes central and multizone conditioners, sprayed coil units, heating and ventilating units, heating and cooling coils, and air-cooled condensers. Types and sizes of all units are available to meet the architectural requirements of all kinds of buildings and weather conditions.

FOR YOUR LIBRARY—if you use information and specifications on air conditioning equipment, write for our complete catalog and a list of nationally known firms using Thermal Engineering's products.

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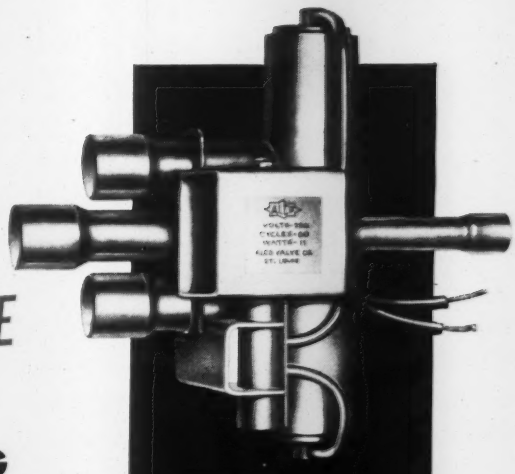
Made by ALCO
OF CAST IRON AND STEEL
like a Compressor
for LONG RELIABLE LIFE



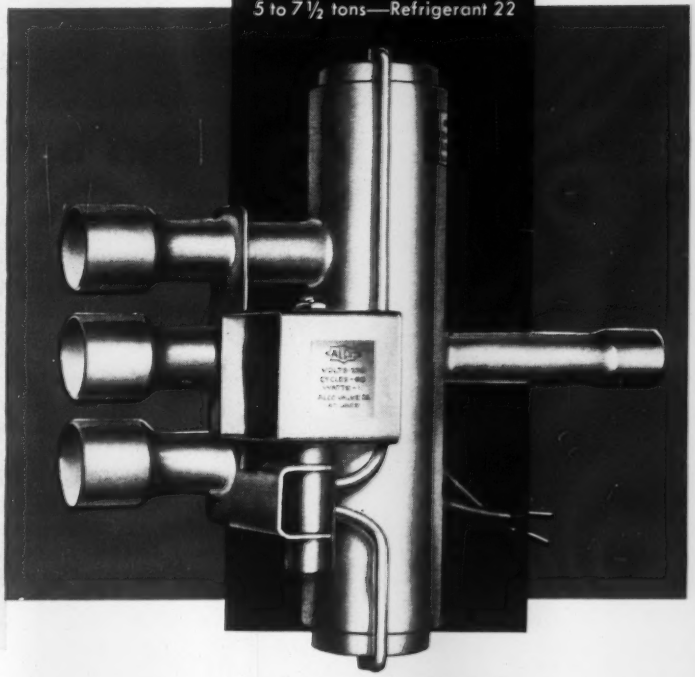
4-WAY REVERSING VALVES
for all reverse cycle systems

#4WB4-57 Capacities:
2 to 3 tons—Refrigerant 12
3 to 5 tons—Refrigerant 22

#4WB6-79 Capacities:
3 to 5 tons—Refrigerant 12
5 to 7½ tons—Refrigerant 22

Features:

- fine machining and precision honing of cast iron slide and steel outer shell—NO PLASTICS ARE USED.
- operating tests of 300,000 cycles without failure to shift and without loss of tight seating—tests made by independent laboratories.
- shifting (change cycle) while the system is in operation with a 300 PSI differential.
- rapid shifting—to shorten change-over time and therefore shorten defrost cycle.
- the shifting of the valve independent of any pressure drops, and efficient shifting under any combination of operating conditions.
- mounting in any position—except with the pilot valve upside down.



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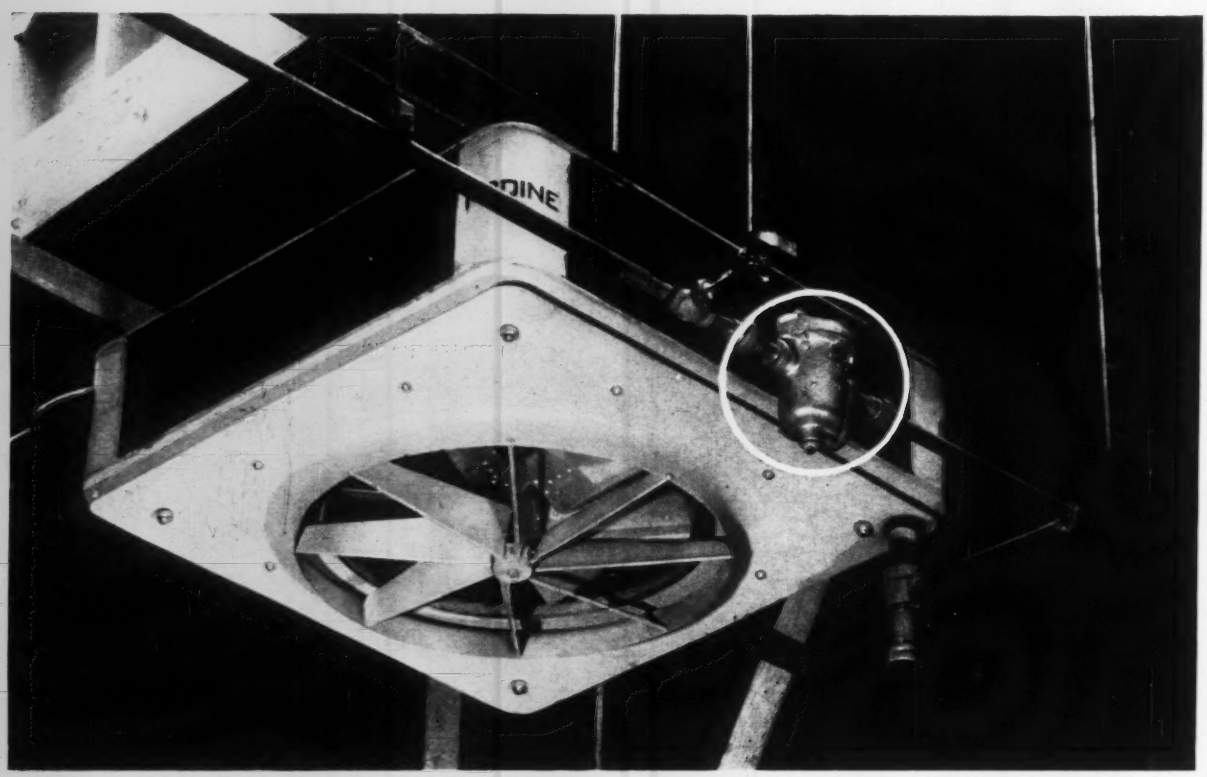
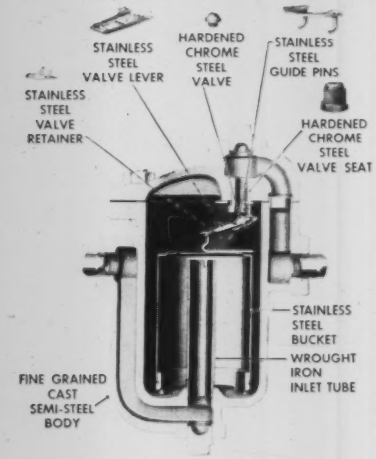
The one complete line of refrigerant controls: Thermostatic Expansion Valves * Refrigerant Distributors * Solenoid Valves * Suction Line Regulators * Flooded Evaporator Controls and Reversing Valves



How Corrosion of Unit Heaters is Prevented by Good Trapping


STAINLESS STEEL VALVE LEVER
HARDENED CHROME STEEL VALVE
STAINLESS STEEL GUIDE PINS
STAINLESS STEEL VALVE RETAINER
HARDENED CHROME STEEL VALVE SEAT
STAINLESS STEEL BUCKET
WROUGHT IRON INLET TUBE
FINE GRAINED CAST SEMI-STEEL BODY

Good design, good materials mean good trapping with Armstrong Traps for unit heaters.

Cause. Costly corrosion of unit heaters is frequently the result of sluggish condensate drainage and inadequate venting. Any carbon dioxide gas present in the steam supply will go into solution if the condensate is below steam temperature, forming corrosive carbonic acid. Presence of oxygen aggravates the corrosion.

Remedy. Armstrong traps prevent carbonic acid formation because they discharge condensate *at steam temperature* and vent CO_2 and air at the same time. There is never any accumulation of condensate and incondensible gases to cause trouble as can occur with traps that must wait for condensate to cool before they will open.

Trap Selection. It is important that the traps be correctly sized, with a generous safety factor to provide adequate air handling capacity. Armstrong sizing recommedations are thoroughly reliable, being based on actual performance of the traps under operating conditions rather than on theoretical considerations.

Complete Details. Ask for Armstrong Bulletin No. 252 which tells how to select and install traps for any type of unit heater. For your free copy, call your local Armstrong Factory Representative, or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8747 Maple Street Three Rivers, Michigan

"See Our Catalog in Sweets Plant Engineering File"

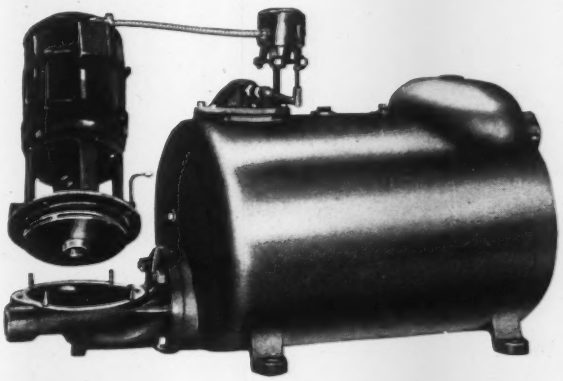
Specify SKIDMORE

FOR PUMP PERFORMANCE NOT PUMP PROMISES

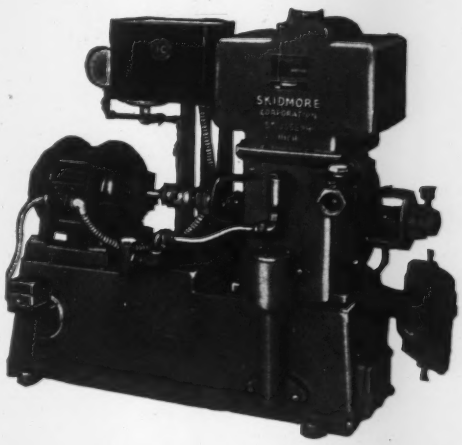
TWO OUTSTANDING SKIDMORE PUMPS THAT HAVE STOOD THE PERFORMANCE TEST!

1 Easily Accessible • • • • • • Compactly Designed

2 Maintained Efficiency — Year After Year



TYPE VC, SINGLE UNIT — low inlet connection . . . quiet operation.



VACUUM PUMP, SINGLE UNIT — automatically adjusts itself to the varying conditions.

There's a Skidmore Pump designed for each and every heating requirement.

Write for Bulletins

SKIDMORE PUMPS

SPECIFY WITH CONFIDENCE

When you specify "Skidmore" Pumps your [illegible] is confirmed by the Skidmore Corporation's [illegible] years reputation and it [illegible] pump performance to meet the [illegible] job.

SKIDMORE CORPORATION ST. JOSEPH, MICHIGAN

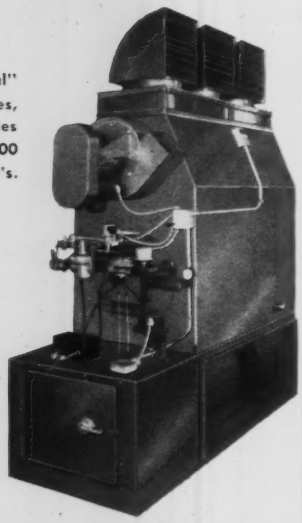
BE CONFIDENT

FOR
SPACE
HEATING

CALL NATIONAL

Only National offers exclusive "total-design" heaters with custom built burners or conventional packaged burners. Choose from the largest selection of styles and sizes in the industry, to fit *every* heating requirement.

Before you select—*call* or *write* National. Be confident you make the *right* space heating decision.



National "Universal" Series ITD, 6 Styles, 96 Sizes—Capacities 400,000 to 4,000,000 BTU's.

Select with Confidence!

NATIONAL HEATER CO.

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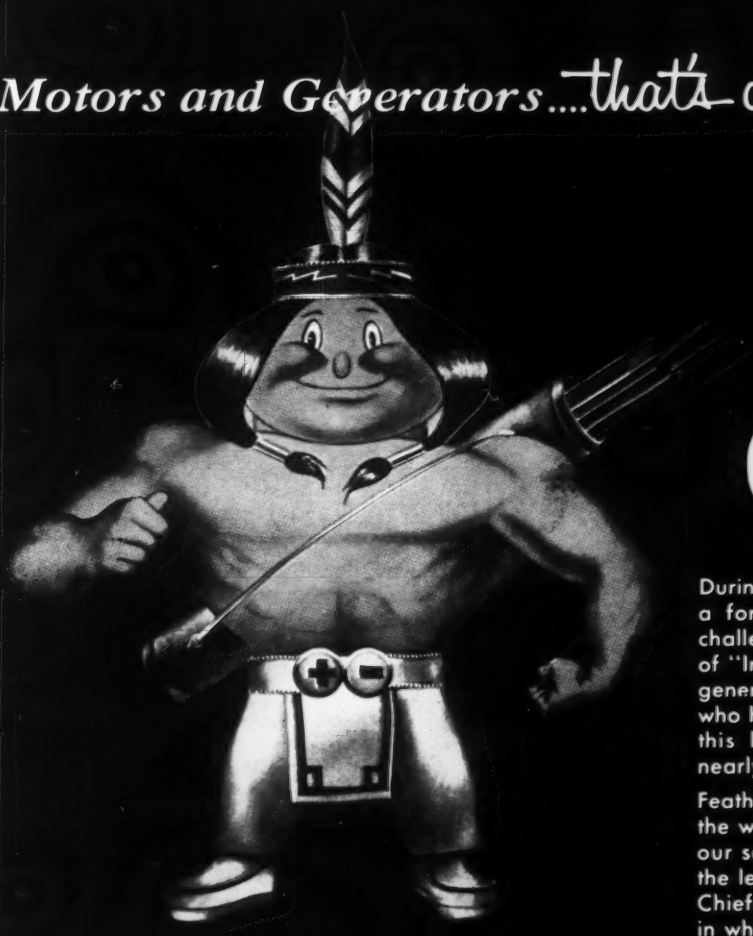
Motors and Generators....that's our Business!



ME* can do!

During your next planning pow-wow on a forthcoming project, consider this challenge (ME* Can Do!) from a tribe of "Injun-eers" who make motors and generators their only business . . . and who have been successfully conducting this business on product merit for nearly 50 years.

Feathers in our bonnet include some of the world's most honored projects and our scalp belt includes a multitude of the leading names in industry, but the Chiefs at ME* are more interested now in what ME* can do . . . for you!

Wherever you are, whatever your requirements, there's an ME* Sales Engineer ready to visit your reservation, sit in at your council fire and discuss your requirements . . . help you with your planning . . . prove the superiority of Marathon Electric Motors and Generators.

This data and specification file on Marathon Electric Motors and Generators is now available for your ready reference use. May we mail you your free copy now?

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Factories at Erie, Pa., and Earlville, Illinois

Offices in Principal Cities

make it

SPANG STEEL PIPE

When it's steel pipe . . .

. . . you're buying pipe with inherent strength and safety. Steel pipe is easy to thread, bend and weld . . . saves you installation time, helps keep construction costs down.

And when you install a steel pipe job, you *know* from experience that it will provide years of satisfactory, trouble-free service. Reliable steel pipe is first choice always for plumbing, air conditioning, steam and radiant heating systems, snow melting, refrigeration, ice rinks and structural uses.

When it's SPANG Steel Pipe . . .

. . . you're buying steel pipe with the *top-quality* reputation. Spang pipe is closely controlled during manufacturing and is thoroughly tested and inspected before shipping.

And when you order Spang, you *know* you're getting top-quality, the best available! Today, you'll find Spang Steel Pipe providing *top-quality* service in thousands of installations in schools, hospitals, industrial plants, office buildings, hotels, apartments, homes and many other types of buildings.

Get the complete story . . .

. . . of Spang Steel Pipe from our new Bulletin No. 509. It describes how Spang is made, shows many typical Spang installations, and contains valuable technical tables. We hope you'll write for a copy.

Meanwhile, your local Spang Distributor is at your service for all your piping needs. Next job, remember for best results: make it Steel Pipe . . . make it Spang! Made in the U.S.A.!

SPANG CW STEEL PIPE

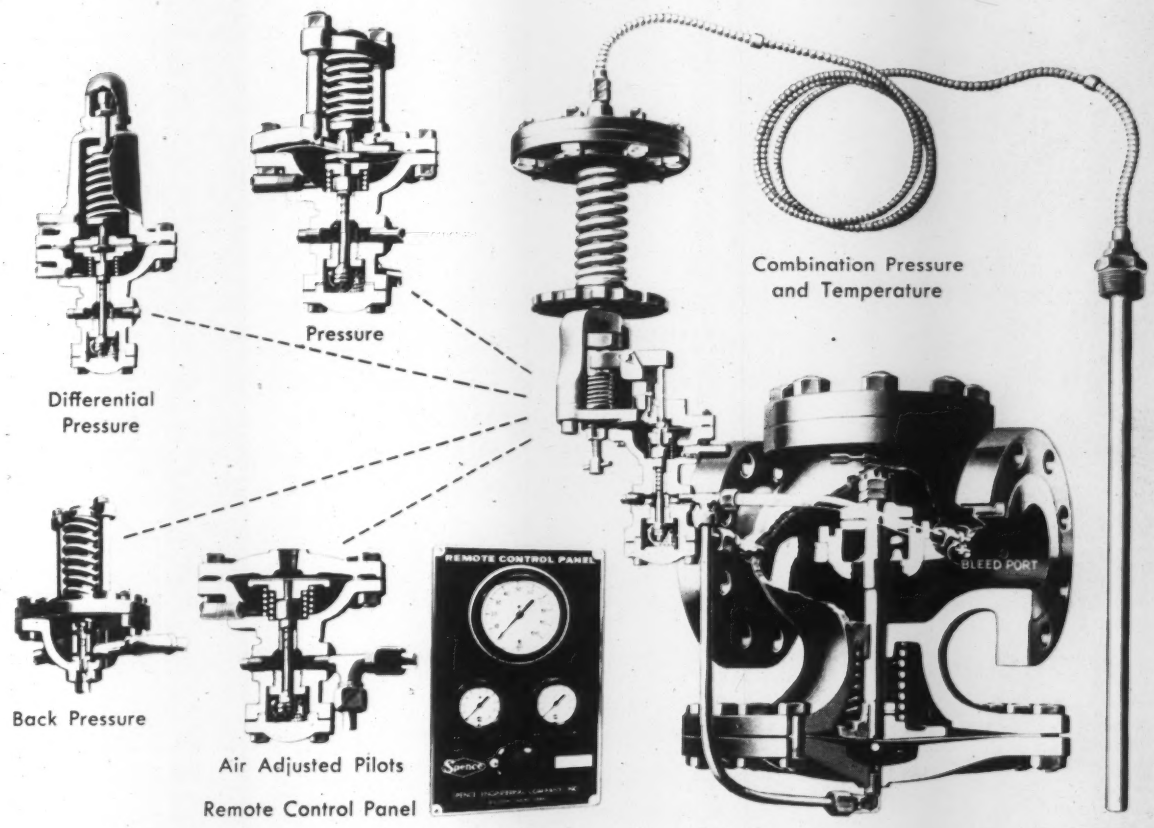
THE NATIONAL SUPPLY COMPANY

Two Gateway Center, Pittsburgh 22, Pennsylvania

Subsidiary of Armco Steel Corporation

VALVE TIPS:

All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced



Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

If trouble does develop, engineers want a regulator they can get back on the line — fast. That's one reason why more engineers are standardizing on Spence Regulating Valves with externally mounted pilots. The simple test of disconnecting the external bends establishes whether the trouble is in the main valve or the pilot.

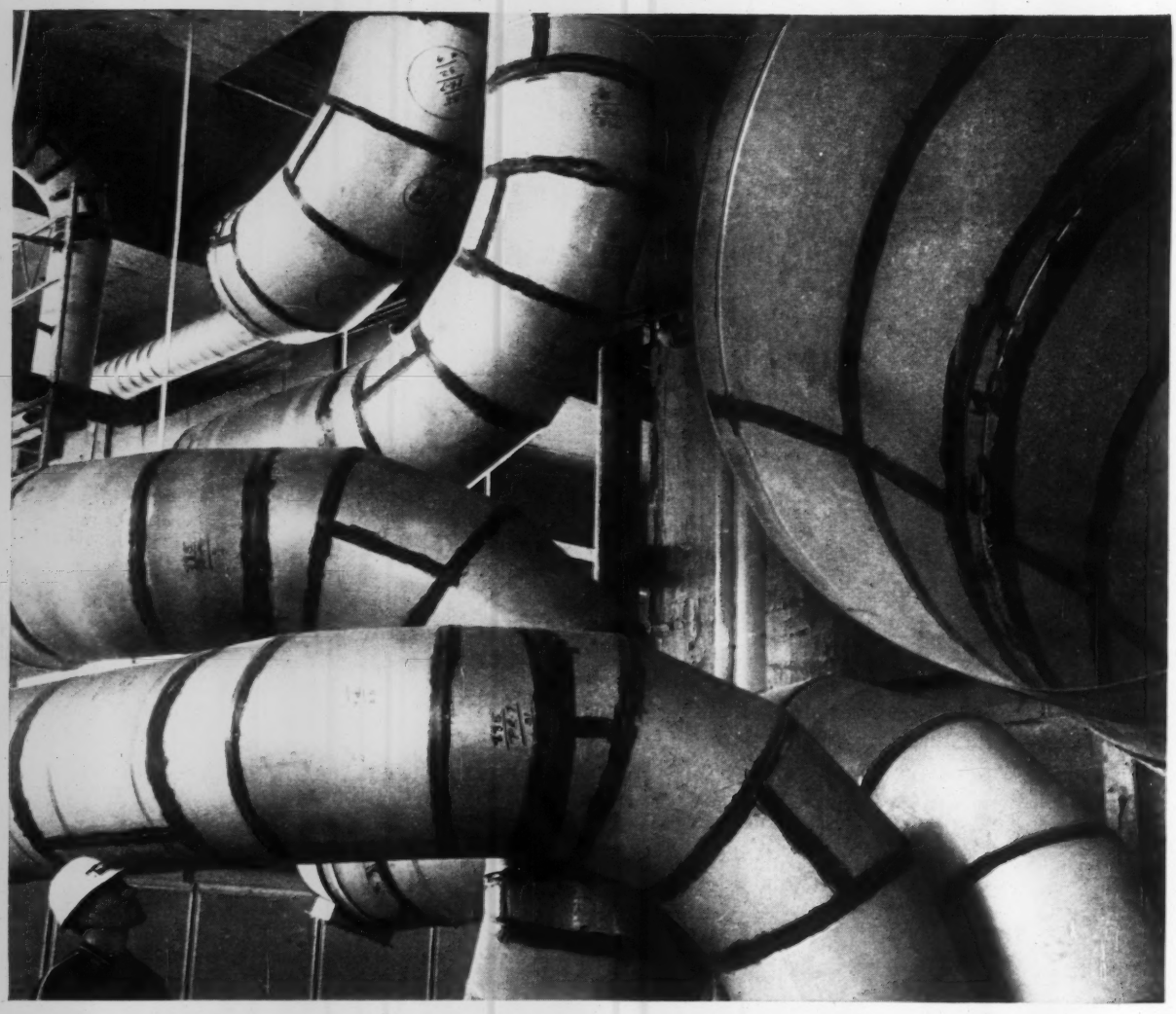
If the main valve is the trouble spot, it can be maintained without removing the valve body from the line. If the pilot is the trouble spot, it is easily removed for cleaning. However, if production downtime is a strong factor, the fastest method is to install a spare pilot and it is inexpensive.

All Spence pilots fit all sizes of Spence main valves. If you have twenty pressure regulators, for instance, all you need is *one spare pilot*. It will fit all main valve sizes from ¼" to 12".

Another advantage of the Spence design is the external pilot is interchangeable. You can change the function of a regulator by merely changing the pilot. In many plants this can represent an important factor in reduced inventory costs because you only carry a few inexpensive extra pilots instead of complete regulators. Obviously, there is also a considerable savings in labor costs when a valve can be converted, in the line, from a temperature regulator to any one of various pressure regulators.

The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York SE-149



Bethcon Galvanized Sheets used in 9,000-ton air conditioning system

The Chase Manhattan Bank's new main office building towers 810 ft into the lower Manhattan skies. Its 60 stories of office space were designed to house 15,000 workers in year-round, air-conditioned comfort.

The 9,000-ton system, believed to be the largest ever installed in a commercial office building, employs various shapes and sections of ductwork, including square and spiral, as well as specially fabricated risers like those shown above. Bethcon continuously galvanized steel sheets were used in all types of ducts.

Bethcon sheet steel is just right for this kind of sheet-metal work. Strong and rigid, it permits long spans with minimum support. Bethcon is neither too hard nor too soft, making shopwork easy and the end-product sturdy. Bethcon's zinc coating is second to none for its refusal to flake or peel off.

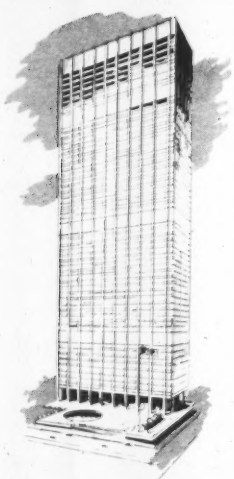
Bethcon is available in a wide variety of gages, with either plain open hearth or copper-bearing (Beth-Cu-Loy) steel. Just get in touch with the nearest Bethlehem representative for whatever details you need.

Steel — For strength ...economy ...eye-appeal

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



The Chase Manhattan Bank Building, New York City. *Architect:* Skidmore, Owings and Merrill; *consulting mechanical engineers:* Jaros, Baum and Bolles; *general contractor:* Turner Construction Company; *mechanical contractors:* Raisler Corp. and Kerby Saunders, Inc., a joint venture; ductwork fabricated by National Sheet Metal Works, Universal Sheet Metal Corporation, and Carrier Corporation.

TO KEEP MAINTENANCE COSTS DOWN . . .

New $6,000,000 Hospital Selects

LUNKENHEIMER VALVES

Thanks to sound planning, valve maintenance expenses in this new Hospital will be kept to a minimum. Lunkenheimer Solder End Valves were installed because, part-for-part, they provide longer maintenance-free performance than any other valves designed for similar service. They have established unmatched performance records on steam, hot and cold water lines, heating and air conditioning systems, as well as oil and gas lines, in commercial, industrial and institutional buildings all over the world. Why put less than the best in specifications, when the best costs no more? For specific recommendations on maintenance-saving Lunkenheimer Valves for new projects or for manufactured equipment . . . write The Lunkenheimer Company, Cincinnati 14, Ohio.

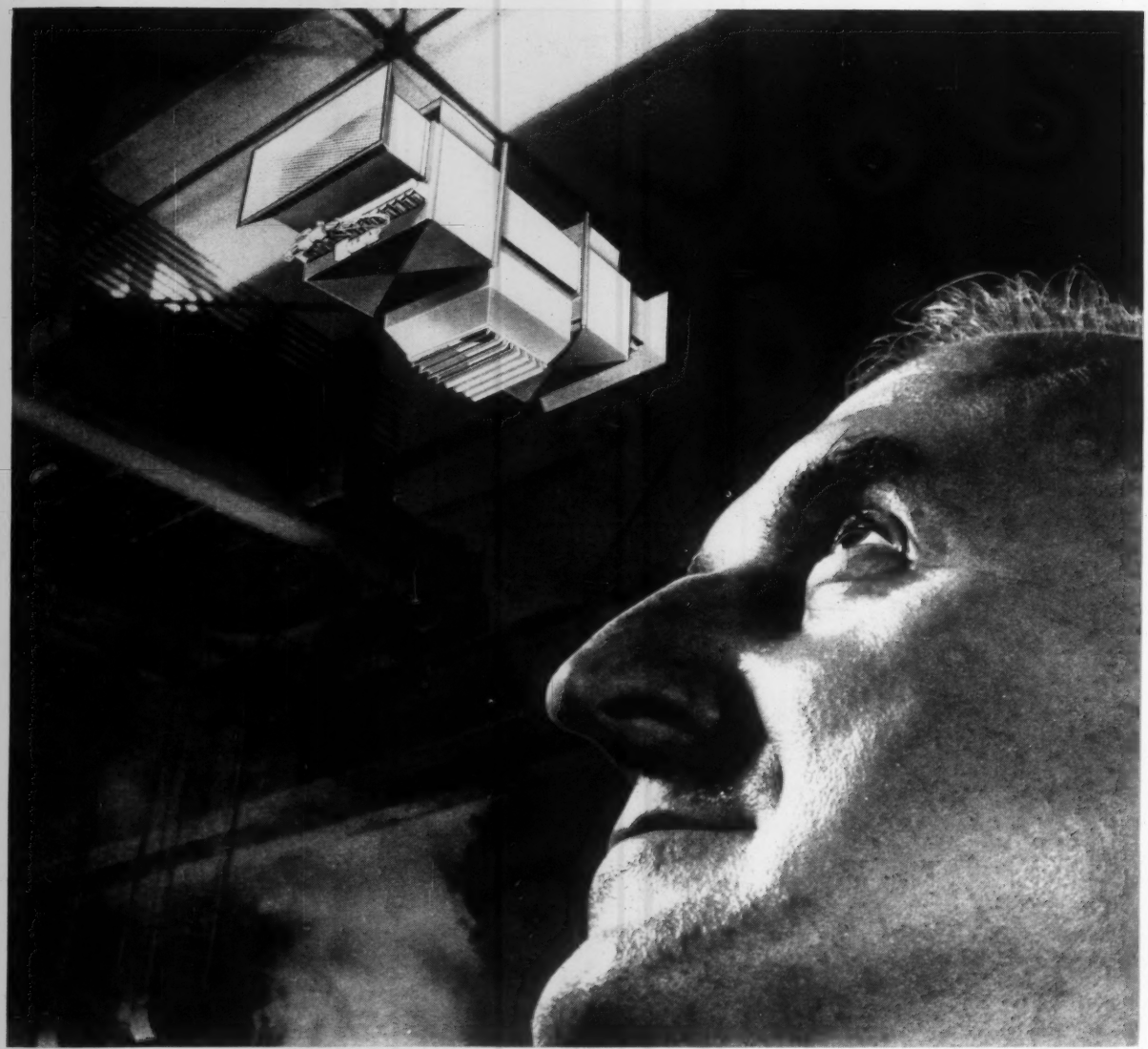
This impressive $6,000,000 structure will house the new Methodist Hospital, located just west of Minneapolis, in St. Louis Park. It will provide over 276 beds and 60 bassinets for the surrounding community, and a four-floor nurses' residence for over 135 student nurses and other personnel.

Hospital Administrator: Vernon T. Spry
Chairman of Building Committee: Clifford G. Retherford
Architects and Engineers: Ellerbe and Company
General Contractor: Kraus-Anderson, Inc.
Mechanical Contractor: Belden-Porter Company

LUNKENHEIMER QUALITY

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES



TOUGH BUYERS DEMAND REZNOR FIVE-WAY HEATERS

to project heat where needed on "difficult" jobs... with no waste!

When cranes, production machinery or huge inventory stacks require abnormally high heater placement, you *have* to be a "tough buyer" to do a proper heating job! You have to deliver a unit that will project heat where it's needed . . . with no waste of fuel *or* heat. That's why so many heating contractors now demand the new Reznor Five-Way Heater, which projects heat downward, even from a height of 40 feet, to the spot where heat is needed, and (with the optional 5-way diffuser) in as many as five directions at once!

LOWER FUEL COSTS—By spotting heat accurately, the Five-Way Heater maintains complete comfort with less fuel; keeps fuel bills low.

LOWER INSTALLATION COSTS—The entire assembly installs quickly, requiring only gas, flue and power connections.

Available with aluminized or stainless steel heating elements and gas modulation. Electric ignition is optional.

For information, phone your Reznor distributor, or write Reznor Manufacturing Co., Dept. 51C, Mercer, Pa.

The heating world is full of tough buyers; that's why Reznor is the world's largest selling direct-fired heater!

REZNOR HEATERS

"THE TOUGH BUYERS' LINE"

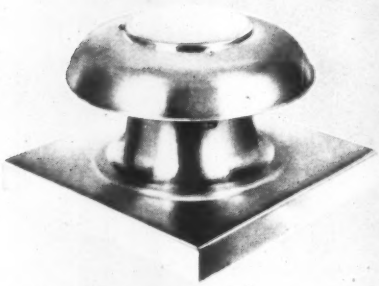
OCTAGON

VENT-X-IT

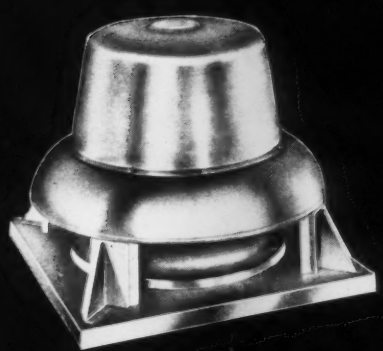
CATALOG NOW AVAILABLE

VOLUME VENTILATION WITH STREAMLINED STYLING

TYPE C DIRECT DRIVE
CENTRIFUGAL VENTILATORS



TYPE P PROPELLER ACTION
POWER VENTILATORS



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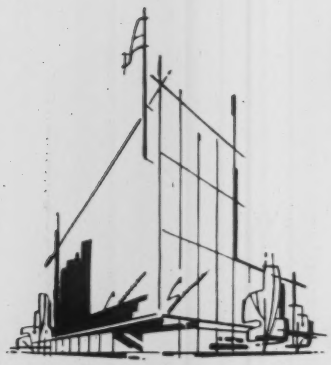
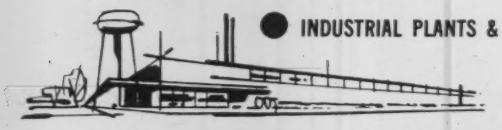
5828-30 S. Oakley Ave., Chicago 36, Il

Curtis cools

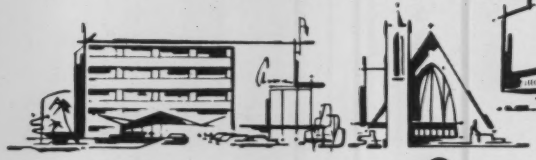


RETAIL STORES & SUPERMARKETS

INDUSTRIAL PLANTS & HOSPITALS



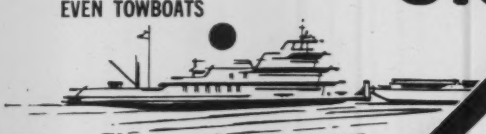
OFFICE & APARTMENT BUILDINGS



HOTELS & MOTELS BANKS & CHURCHES

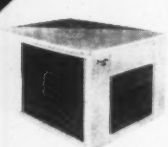
etc.

EVEN TOWBOATS

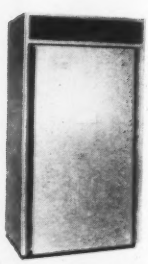


C-101

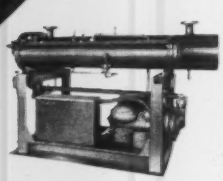
with



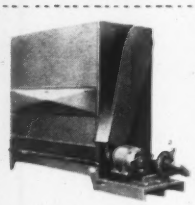
Packaged Air Cooled Conditioning Units 3 thru 10 Tons



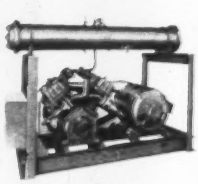
Packaged Air Conditioning Units 3 thru 60 Tons



Packaged Liquid Chillers 7½ thru 125 Tons



Matching Evaporative Condensers, Cooling Towers and Air Handling Units



Condensing Units 3 thru 100 Tons

And in all applications—Curtis units perform dependably, always up to and frequently surpassing rated capacity. Key thing to remember is this . . . Curtis manufactures a complete line of units ideally suited to any application facing the engineer or mechanical contractor. Space saving, versatile Curtis equipment delivers dependable performance in installations of all types . . . and you will find the cost very much in line. This equipment allows for easy installation and servicing.

THE COMPLETE LINE OF LIQUID CHILLERS • PACKAGED AIR CONDITIONERS • CONDENSING UNITS

Curtis MANUFACTURING COMPANY • REFRIGERATION DIVISION • *Established 1854*

Dept. 5, St. Louis 33, Missouri

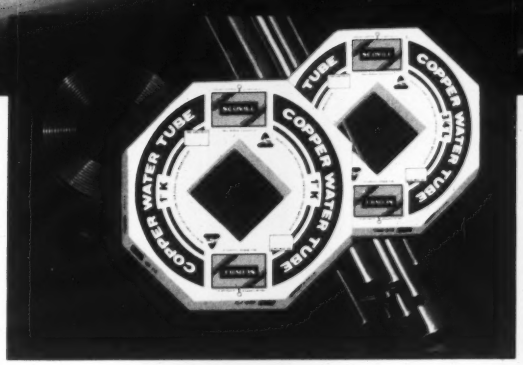
BRING OUT THE BEST

IN EVERY INSTALLATION WITH

SCOVILL®

DWV

copper drainage tube



Scovill's complete NEW line of 100% U. S.-made Copper Tube Mill Products includes . . .

COPPER WATER TUBE K-L-M
COPPER DRAINAGE TUBE (DWV)
COPPER THREADLESS PIPE (TP)
COPPER PIPE
RED BRASS PIPE
COPPER REFRIGERATION TUBE

• Sold only through Wholesalers •

There are **at least six** good reasons why this is the fastest growing trend in plumbing

Scovill Copper Drainage Tube (DWV) is *lighter* in weight, hence easier to transport, easier to handle and install. It is *more compact*, can be enclosed *within* standard walls and partitions. It *saves time;* soldered joints make up faster; complex assemblies can be prefabricated. *Compact fittings* permit close-quarters work impossible with other materials . . . make it easy to meet "special" job needs. You can depend on *superior tightness* of sound solder joints in precision-made tube and fittings, plus *proven service* of lifetime solid Copper.

Scovill Copper Drainage Tube (DWV) also simplifies stocking, cuts with less waste, saves you time and money all the way. It is being approved by more and more architects, builders and code authorities every day for quality installations. It's one of the fine new product trends in building *you* should be following now.

. . . made better to bring out the ***BEST*** *in every installation*

SCOVILL MANUFACTURING COMPANY • COPPER TUBE MILL PRODUCTS, WATERBURY, CONNECTICUT

2SC60

Save Time on Slab Perimeter Jobs

Pacific Mutual Insurance Company, Des Moines, Iowa. Owner—Charles Witthaus Realty Co. Gen. Contr.—Jorge Construction Company. Htg. & Air Cond. Contr.—Air-Con, Inc. Plbg., Htg. & A/C Engr.—James E. Turner. Architect—Linscott-Kiene & Haylett

...by using

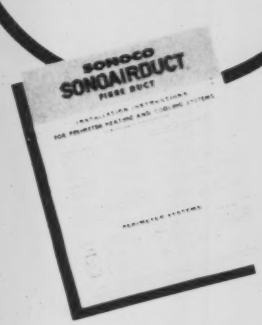
SONOCO
SONOAIRDUCT®
FIBRE DUCT

Lightweight and easy to handle, SONOAIRDUCT Fibre Duct joins and levels faster... saving labor and installation time on slab perimeter heating or combination systems. And, SONOAIRDUCT can be quickly cut to exact lengths with a hand saw.

You can be assured of consistent high quality when you use Sonoco SONOAIRDUCT Fibre Duct—because it meets or exceeds all F. H. A. criteria and test requirements for products in this category.

Available in 23 sizes—2" to 36" I.D. Order required lengths or standard 18' shipping lengths. SONOAIRDUCT Fibre Duct saves you money, too... it's low in cost and won't chip, crack, or break when dropped—every piece is usable.

FREE INSTALLATION MANUAL

contains latest, detailed, step-by-step installation data for SONOAIRDUCT Fibre Duct. For free copy, send us your name and address on company letterhead.

4773

See our catalog in Sweet's, or write for complete information to

SONOCO
Construction Products

SONOCO PRODUCTS COMPANY, HARTSVILLE, S. C. • La Puente, Calif. • Fremont, Calif. • Montclair, N. J. • Akron, Indiana • Longview, Texas • Atlanta, Ga. • Brantford, Ont. • Mexico, D. F.

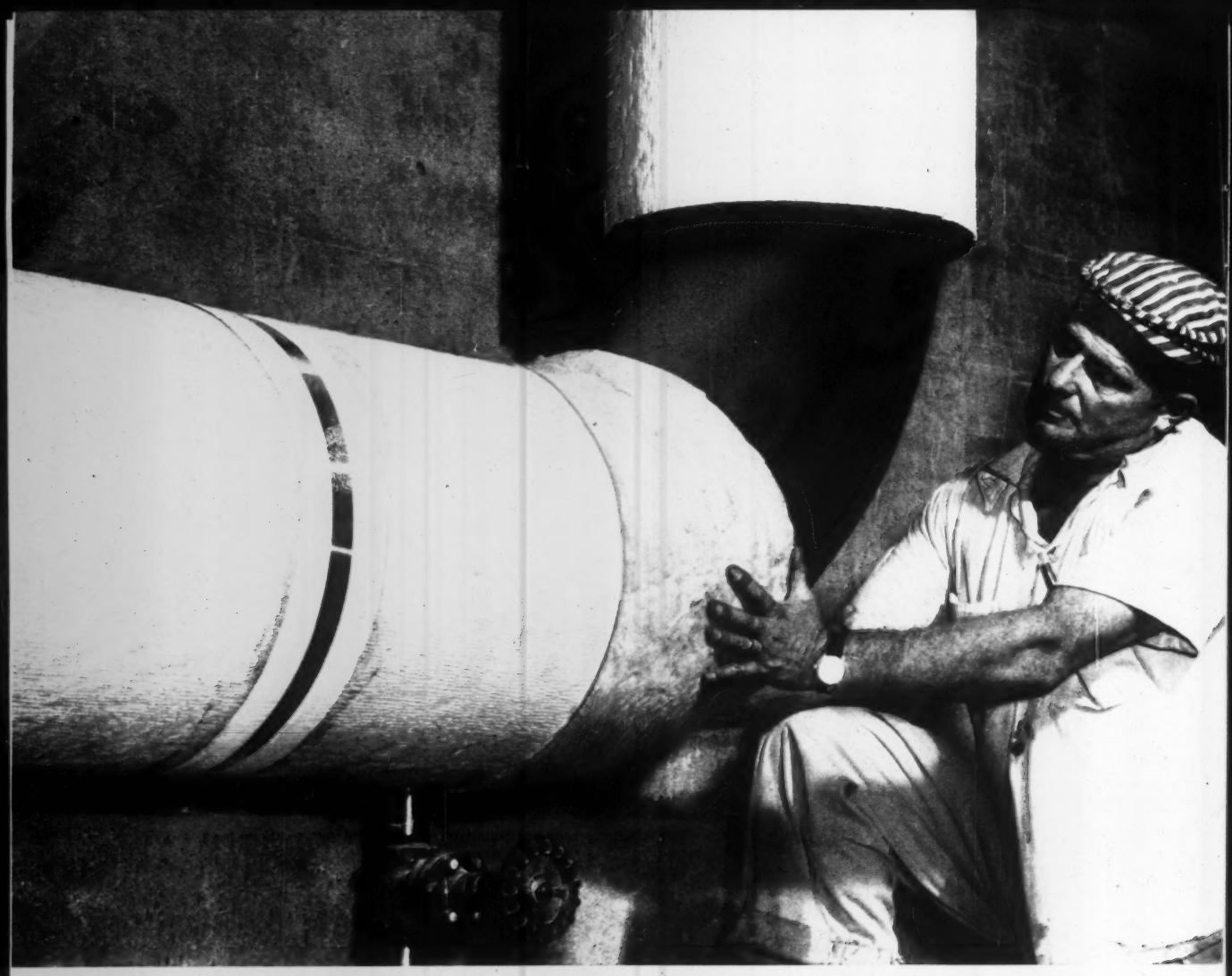
If you're a heads-up, both-feet-on-the-ground kind of man who knows his way around in business – you're sold on your businesspaper. You know from profitable experience, there's nothing else in print so packed with facts, news, and good ideas that help you stay on top in business as the advertising and editorial pages of . . . your businesspaper.

PHOTO ON LOCATION BY EHRENBERG

Where there's business action, there's a businesspaper . . . where there's heating, piping, and air conditioning business, there's Heating, Piping and Air Conditioning

BUSINESS PAPER LEADERSHIP ABP AUDITED PAID CIRCULATION ABC

of a series of advertisements prepared by the ASSOCIATED BUSINESS PUBLICATIONS



try this on your pipe...

(it's Pittsburgh Fiber Glass Pipe Insulation)

Acme Insulation Company, Pittsburgh, did . . . on the piping job at Pittsburgh's new Gateway Parking Garage in Gateway Center. And here's what Acme owner Walter S. Peebles says about this installation:

"We chose Pittsburgh Fiber Glass Insulation for its efficiency, appearance and permanence. It's lightweight, handles easily, cuts readily with a knife, is quickly applied. There's a minimum of waste material.

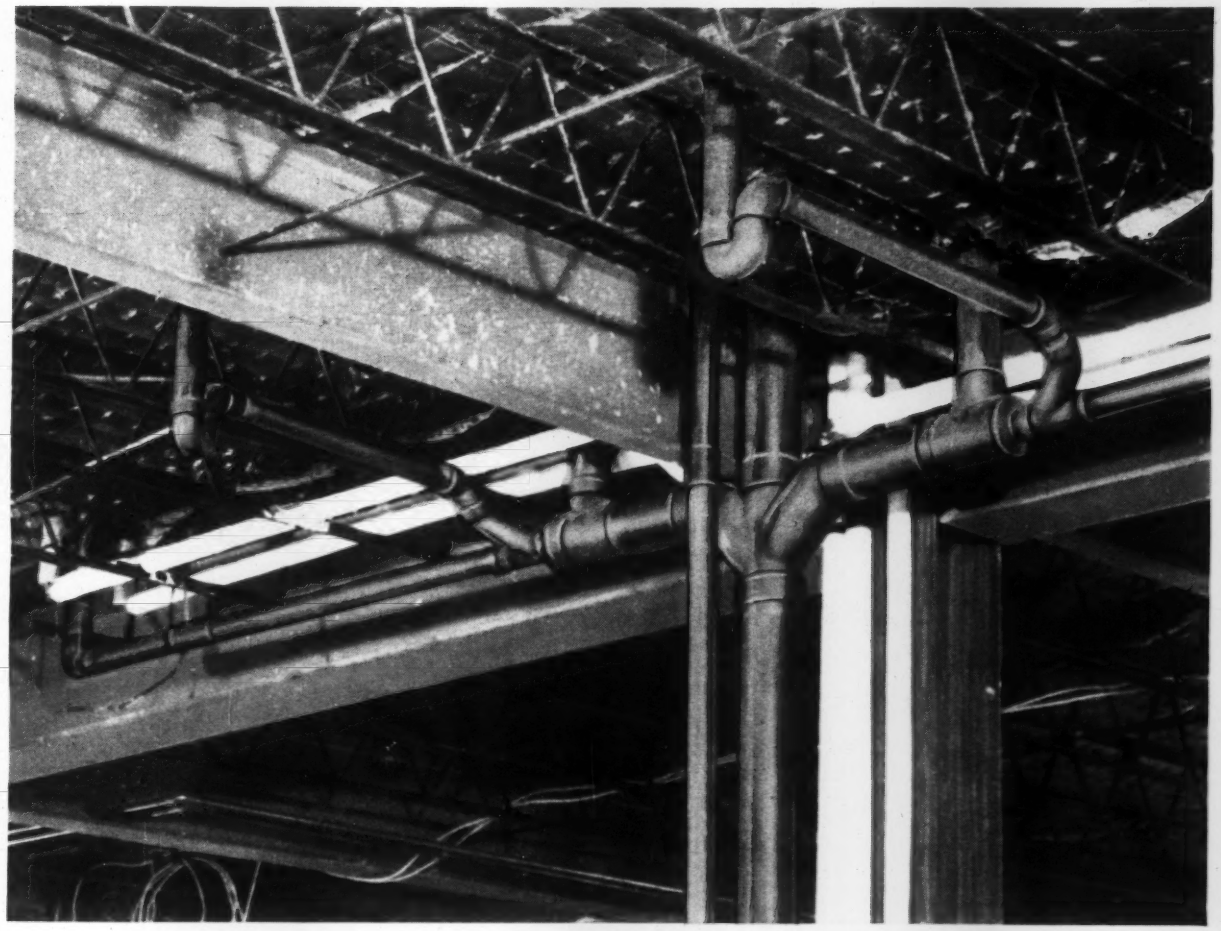
"We've found that Pittsburgh Pipe Insulation holds its size and shape, does not effect the metal it covers, and has a fine record for low-cost maintenance. We used 8,300 ft of it on ½" to 14" pipe for underground heating, snow melting, chilled water lines, general plumbing, sill cocks and drain lines.

"It's probably the finest insulation that can be used, especially in subsurface locations."

FOR TOP THERMAL CONTROL, THIS IS IT! Pittsburgh Fiber Glass Pipe Insulation is a molded flexible hollow cylinder, slit along its length to provide quick application to pipes or tubing. It has high thermal efficiency for any type pipe insulating job and is surprisingly economical. You can get complete details from your nearest PPG Fiber Glass Sales Office, or by writing to *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Penna.*

SALES OFFICES: Atlanta, Attleboro, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Fort Wayne, Houston, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco and Washington.

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY



SAVE SPACE WITH COPPER TUBE. Anaconda copper tube and fittings assemblies are compact, result in greater ceiling height and more usable floor area. No need to build wide plumbing walls—a 3″ copper tube stack with fittings will fit inside a 4″ partition. Overhead work is easier because copper plumbing is about *one fourth* the weight of ferrous materials. In close quarters, copper makes light work out of tight work. Use these space-saving modern plumbing materials—Anaconda copper tube and solder-joint fittings—for your next water supply AND sanitary drainage installation. For more information on copper tube, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

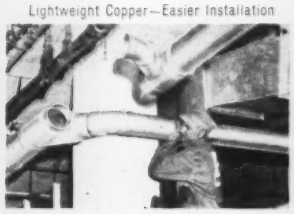
ANACONDA® **COPPER TUBE AND FITTINGS for soil, waste and vent lines**

Available through plumbing wholesalers. Products of the American Brass Company

Longer Lengths—Fewer Joints

Preassembly—Saves Time

Lightweight Copper—Easier Installation



Easier Remodeling

Photo courtesy of Turner Construction Company

Built to an "Only the Best" specification

. . . equipped with JENKINS VALVES

The Interchurch Center
New York City

Poised on a bluff 100 feet above the Hudson River, this $21 million structure houses 2,000 individuals representing 144,000 local Protestant and Orthodox congregations embracing 40,000,000 members in the United States. Its imposing limestone facing alone represents a substantial investment in beauty as well as permanence.

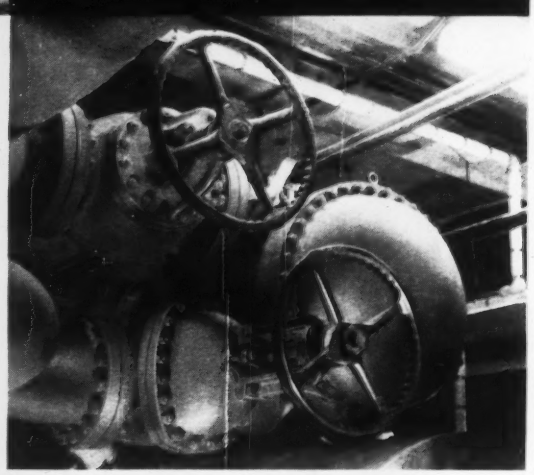
Architects: COLLENS, WILLIS & BECKONERT –VOORHEES WALKER SMITH SMITH & HAINES. *General Contractor:* TURNER CONSTRUCTION COMPANY. *Plumbing Contractor:* C. H. CRONIN, INC. *Heating, Ventilating, Air Conditioning Contractor:* RAISLER CORPORATION.

A magnificent culmination to a fifty-year dream of bringing Protestant and Orthodox communions in America together under one roof, The Interchurch Center is an outstanding New York building, as well. It is especially noteworthy for an overall high quality in construction and equipment. Planned to be a symbol of unity that would endure for generations, architects and contractors could be satisfied only by "the best" in everything.

When it came to valves for both the central air conditioning system and the heating system with its three low pressure boilers, all building factors agreed on JENKINS. They could be sure Jenkins Valves would deliver an unusual measure of long-time efficiency and economy. And, as practical planners, they appreciated the fact that Jenkins Valves cost no more than any good valves.

When YOU choose valves, remember that you pay no premium to specify the valves so often favored by the country's top building authorities. Jenkins Bros., 100 Park Ave., New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

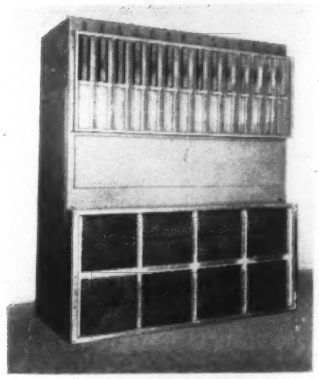


Jenkins Iron Valves on water lines of condensor

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros

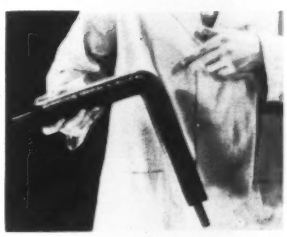
EQUIPMENT DEVELOPMENTS . . .

For reviews of Recent Trade Literature see page 214



Air Conditioners . . .

. . . packaged, in 25, 30, and 40 ton sizes with capacities of 10,200 cfm, 12,600 cfm, and 17,100 cfm respectively, for single large space or multizone conditioning; with top horizontal or up-blast discharge, may be equipped with steam or hot water heating coil, furnished with "tamperproof" control panel, optional inlet filter boxes—*American-Standard Industrial Div., Detroit 32, Mich.*

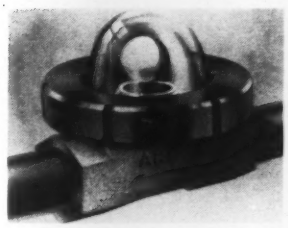


Pipe Insulation . . .

. . . plastic, for 0 to 220 F ranges in 3 wall thicknesses, with smooth outer surface; said to be moisture resistant, and to afford minimum shrinkage under high temperature conditions; can be applied to sharp bends and elbows without cracking; multiple thicknesses may be used for lower temperatures.—*Armstrong Cork Co., West Liberty St., Lancaster, Pa.*

Welding Fittings . . .

. . . seamless steel in sizes to 24 in., with machined ends, compression sizing for positive shape; wall thicknesses and uniformity said to be greater than that required by ASA standards; fittings complement line of standard welded fittings in sizes through 48 in. and special material units—*Midwest Piping Co., Inc., 1150 S. Second St., St. Louis 4, Mo.*

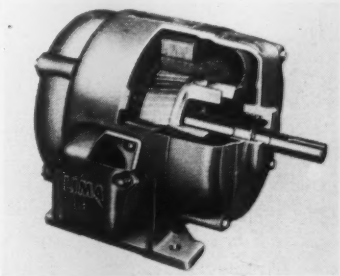


Flow Indicator . . .

. . . for flows as low as 0.075 gpm water and ½ cfm gas utilizes free ball in glass dome; in ½ in. pipe size for pressures to 100 psi, has bronze body and synthetic composition ball—*McIntosh Equipment Corp., Walker, Crosweller Div., 15 Park Row, New York 38, N.Y.*

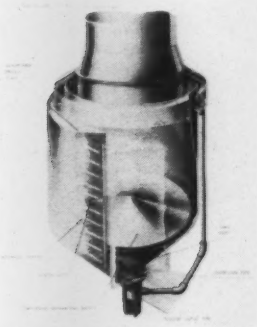
Dial Thermometers . . .

. . . immersion type vapor actuated in 6 standard ranges: −40 to +65 F up to 100 to 350 F; feature progressively graduated scale, brass fitting construction, adjustable angle, rigid, or remote reading design, interchangeable ½, ¾, or 1 in. brass sockets, 3½, 4½, 6, and 8½ in. dials; bronze, monel, steel or stainless sockets available for special applications—*Weksler Instruments Corp., 195 E. Merrick Rd., Freeport, L.I., N.Y.*



Electric Motors . . .

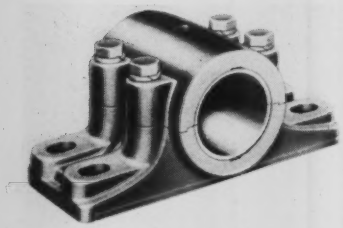
. . . in 1 to 150 hp ratings, frame sizes 182 through 505, with solid die cast rotors, integrally cast cooling fans, cast iron end bells, "dripproof" case; aluminum connection boxes are diagonally split, may be rotated for ease of connection; in 2 or 3 phase models, standard frequencies and commercial voltages below 600—*The Lima Electric Motor Co., Dept. 519, Lima, O.*



Air Scrubber . . .

. . . for fine particle control, in variety of sizes; combines agglomeration and separation units within one housing; available in capacities to 40,000 cfm, operates in static pressure range of 10 to 30 in. water gage, with water for particle-collecting medium, can be grouped for multiple unit use—*The Ducon Co., Inc., 147 E. 2nd St., Mineola, N.Y.*

EQUIPMENT DEVELOPMENTS
Continued



Pillow Blocks . . .

. . .of rigid 4-bolt design for 3-7/16 to 8 in. shaft sizes, split journal design for 1-15/16 to 2-15/16 in. sizes, plus angle designs for all standard shafts; with bronze bushings for liner-changing without removal of lower half of housing, steel housings; brass retainer spool prevents rotation of liner with shaft; special alloy liners available on special order—*Dodge Mfg. Corp., 500 S. Union St., Mishawaka, Ind.*

Expansion Joint . . .

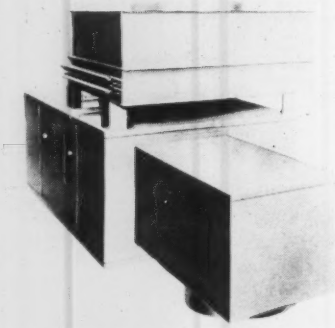
. . .of piston seal design, for tubing, said to compensate for expansion of 100 linear ft of copper for 120 F temperature rise or 35 F temperature drop; uses O-ring seals, coupling ends may be rotated 360 deg for ease of installation—*General Fittings Co., East Greenwich, R.I.*

Electric Motors . . .

. . .in ½ to 125 hp sizes, 3-phase, squirrel cage induction type; with plastic-insulated stators, die cast aluminum rotors, designed for horizontal or vertical shaft operation, has fabricated steel frame, specially designed dust caps to protect inner surfaces, according to manufacturer—*The Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, O.*

Pipe Locator . . .

. . .transistorized, for underground tracing of pipes, valve location, etc.; portable unit consists of transmitter and receiver each powered by 4 flashlight batteries; may be operated with both units on carrying handle or with stationary transmitter-moving receiver; equipped with earphones, visual meter, plastic carrying case, 3-position sensitivity switch, variable gain control—*Gardiner Electronics Co., 2545 E. Indian School Rd., Phoenix, Ariz.*



Air Conditioner . . .

. . .year 'round, for roof mounting; 10 ton summer conditioner features air-cooled condenser with vertical discharge fan, hermetic compressor; with 240,000 Btu per hr gas-fired heater, unit includes integral air filters, controls, is furnished with distribution plenum and diffuser; end-positioned intake and discharge connections allow placement over weight-bearing structural members; unit measures 90 by 60 in., is 80 in. high—*Typhoon Air Conditioning Div., Hupp Corp., 505 Carroll St., Brooklyn 15, N.Y.*

Welding Fittings . . .

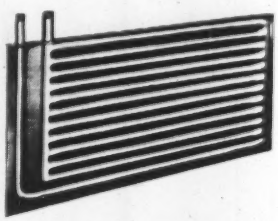
. . .line includes 45 and 90 degree elbows, straight and reducing tees, concentric reducers, and eccentric reducers in 1 through 6 in. sizes; fittings are designed for non-critical installations, meet A.S.T.M. specification A234, according to manufacturer—*Nibco Inc., Nibcosteel Div., 500 Simpson St., Elkhart, Ind.*

Pipe Cutter . . .

. . .of ⅛ to 2 in. capacity, for hand or power drive use, features extra-wide rollers to prevent spiraling, "clear-view" cutting wheels for ease in setting to mark—*Beaver Pipe Tools, Inc., 310 Dana Ave., Warren, O.*

Condenser Controls . . .

. . .for use with manufacturer's air cooled condenser line, consists of adjustable control and balancing valves, designed to regulate system during low ambient periods by maintaining head pressure sufficient to keep compressor operating; may be located anywhere in line and used in parallel on larger capacity systems—*Recold Corp., 7250 E. Slauson Ave., Los Angeles 22, Calif.*

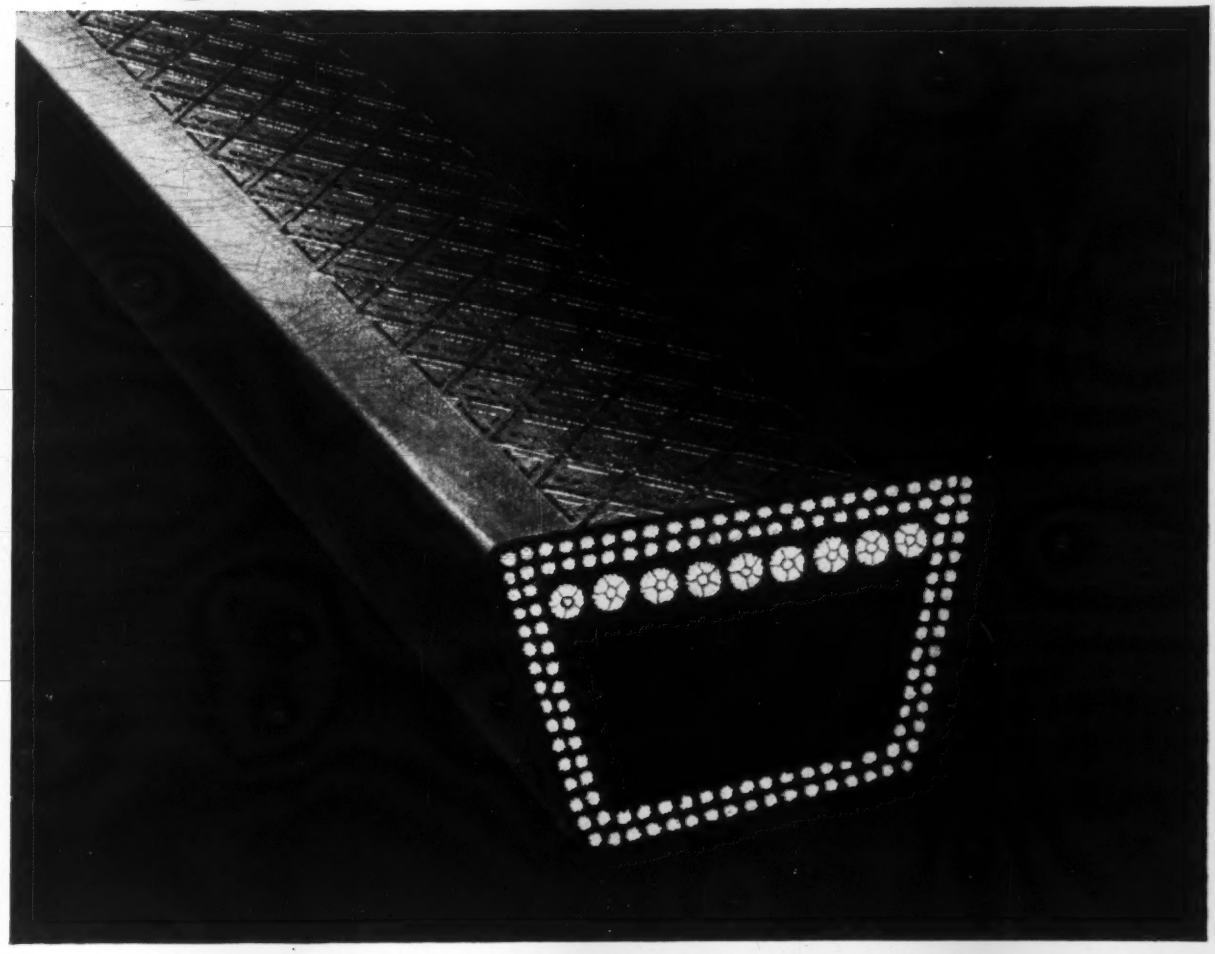


Prefabricated Coil . . .

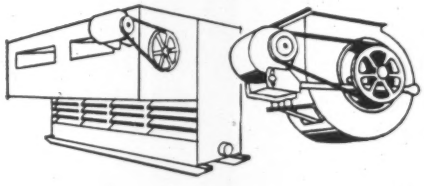
. . .for radiant heating and cooling applications, in 5 standard widths to 29 in. maximum, lengths up to 143 in.; manufacturer states coil is easily installed and replaced, features high Btu transfer rate, weight and space-saving design; data sheet series "15" through "59" available on request—*Dean Products, Inc., 1018 Dean St., Brooklyn 38, N. Y.*

AUTO AIRCON STEEL CABLE V-BELTS
from the Power Unlimited complete belt line

Patented curing method keeps all the steel pulling members in the same plane. They remain straight, are never wavy.



Quiet...smooth... vibration at the vanishing point



For silent and efficient operation of fans, pumps, compressors, blowers —for best power transmission in air-conditioning and refrigeration units —specify U. S. Auto AirCon Steel Cable V-Belts. These belts have everything required in a belt for air-conditioning use. They are in a class by themselves. Forget your negative experiences with other V-belts. U. S. Auto AirCon V-Belts have pulling cords of steel. A new, patented curing method and electronic tensioning of the steel cords *free this belt from vibration.* Power is transmitted smoothly, quietly, efficiently. It has been proven in rugged, automotive air-conditioning service. This belt has outlasted other belts up to 2½ times longer.

Our transmission engineers stand ready to consult with you on any and all transmission belt problems. Drop us a line at the address below.

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WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

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EQUIPMENT DEVELOPMENTS
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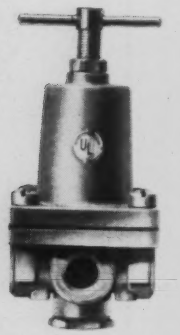
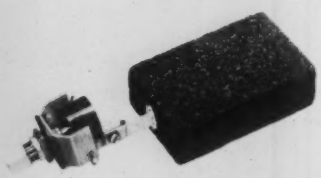


Pressure Regulators . . .

. . . in two models for LP or acetylene gases, of die cast zinc and brass construction, available in ¼ in. size only; may be used as 2-3, or 4-way regulators on air, steam, water and the above gas systems; catalog available on request—*Watts Regulator Co., Industrial Div., Embankment Rd., Lawrence, Mass.*

Air Conditioner . . .

. . . summer, in 10 and 15 ton models, with remote condenser, twin compressor, two fan-coil units; air-cooled condenser has aluminum fins, copper tubing, vertical discharge fan, low silhouette; time delay relay provided for step-starting; fan-coil sections of modular design for varied fan mounting, 3-directional discharge —*Westinghouse Electric Corp., Air Conditioning Div., P.O. Box 510, Staunton, Va.*

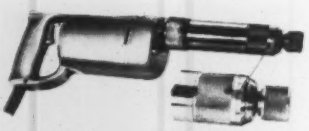


Float Valve . . .

. . . for use on evaporative coolers, other automatic water control operations, operates on single-pivot principle, has reversible and adjustable rubber valve seat, chrome plated valve jet, foam glass float assembly—*Skuttle Mfg. Co., Milford, Mich.*

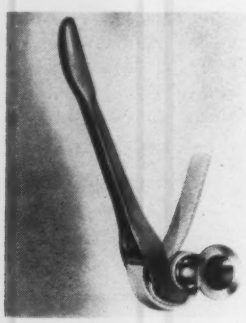
Pipe Insulation . . .

. . . for standard pipe fittings in ½, 1, 1½, and 2 in. thicknesses, standard sizes for ells, tees, and special shapes on request; delivered in two halves for installation with wire, tape, or staples; literature available on request—*Fibrous Glass Products, Inc., Alpha Plaza, Hicksville, L.I., N.Y.*



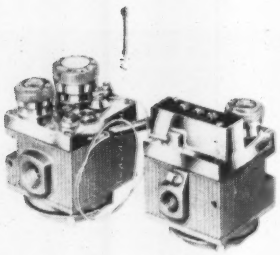
Masonry Drill . . .

. . . for carbides from ½ to 1⅛ in; operates on variable impact, with spring-loaded hammer to strike drill chuck twice per revolution; will sink ¾ in. hole 3 in. in 180 seconds, according to manufacturer; impact adjustable, can be started with rotary action only; with 115 v a-c 60-cycle motor, packed with ½, ⅝, ¾, and ⅞ in. bits—*Moorhead-Crego, Inc., 645 S. Green Rd., Cleveland 21, O.*



Strap Wrench . . .

. . . for use on cylinders, hand wheels, highly polished materials, etc.; with fabric strap, handles in 12, 18, and 24 in. sizes.—*Lowell Wrench Co., 97 Temple St., Worcester 4, Mass.*

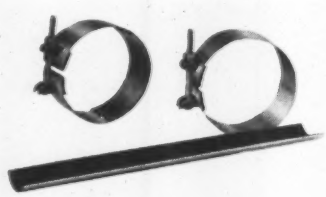


Gas Valve . . .

. . . for space heater application, in electric model for remote thermostat control, or in mechanical model for thermo bulb-capillary tube control; can be used with all heating gases, has optional gas pressure regulator; safety valve provides partial opening until pilot burner ignition, complete shut-off in case of pilot outage; case and control knobs of cast aluminum—*Controls Co. of America, Heating & Air Conditioning Div., 2450 N. 32nd St., Milwaukee, Wis.*

Scale Models . . .

. . . of 20 vessels, 8 heat exchangers, 11 pumps in 3 types plus pipe, fittings, and structural shapes; of polystyrene, parts can be worked with hand tools; line is said to include most items required for piping design model, parts are available from stock —*Industrial Model Supplies, Inc., 2306 Sconset Rd., Wilmington 3, Del.*

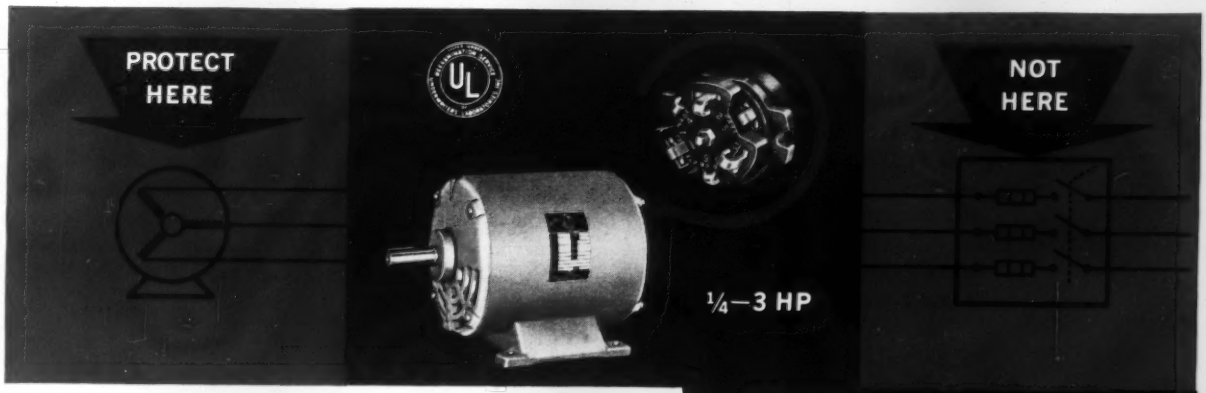


Pipe Clamp . . .

. . . for leak repair, with strip-type gridded gasket on metal backing; clamp lug base said to minimize crushing pressure while exerting high circumferential pull; supplied in 18 in. gasket lengths with 3 or 1¼ in. widths, can be used in multiple for any length repair up to 30 in.; 18 by 30 in. gasket sheet also available—*Smith-Blair, Inc., 535 Railroad Ave., South San Francisco, Calif.*

BIG NEWS!
Now you can STOP 3-PHASE MOTOR BURNOUTS

Right where they start: INSIDE THE MOTOR



K-C INHERENT-PROTECTED OPEN MOTORS
. . . U/L approved for 67 types, 1/4 to 3 HP

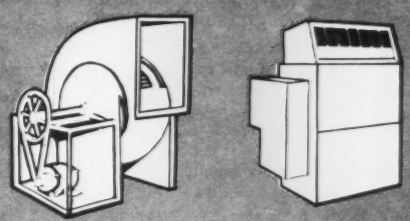
Now you can prevent costly machinery down-time caused by 3-phase motor burnouts . . . and cut installation costs at the same time. Get your motor protection built-in, tested, U/L approved . . . at the factory!

GUARDS PERFORMANCE—The Inherent Protected Motor is completely self-protected against the very conditions that, up till now, have caused most 3-phase motor failures. And, it's tamper-proof!

CUTS COSTS—Overload current relays and 3-pole magnetic contactors in the motor starter can be eliminated. And, this motor is just as easy to install as ordinary designs.

Your Howell representative will be glad to give you complete information.

PROTECTS MOTORS DRIVING:



- Fans
- Blowers
- Compressors
- Air conditioning units
- Pumps
- Machine tools
- Conveyors
- All 3-phase applications—¼-3 hp.

AGAINST these conditions:

- Heavy overloads
- Stalling
- Single phasing
- Unbalanced voltage
- Failure to start
- Motor ventilation obstruction
- High ambient temperatures
- Plugging or reversing duty

SAMPLE MOTORS IN TWO WEEKS

Sample motors within the range of U/L approval, can be supplied in approximately two weeks. Approval covers 3-phase motors, ¼ through 3 horsepower. Send specification details with your request.

HOWELL
electric motors company
THE KINGSTON-CONLEY DIVISION
PLAINFIELD, NEW JERSEY

K-C

A-1984A

HOW TO SAVE
80% PIPE HANGING TIME!

★ Fits all ½" to 8" metal or plastic pipe

★ Listed by Underwriters' Laboratories, Inc., Approved by Factory Mutual Laboratory

★ Self-locking, compact, attractive

★ Safe load exceeds rating for standard types—safety factor 5:1

"AUTO-GRIP" was designed by "Automatic" Sprinkler Corporation industrial engineers for their own use as piping installation contractors. "AUTO-GRIP" ease, simplicity, speed and economy soon established it in the trade as the top improvement in pipe hanging efficiency in 50 years!

LOWER INITIAL COST—competitive with least expensive outmoded, cumbersome rings, bands and clevises.

SMALLER INVENTORY—universal adaptability permits quantity buying of fewer types—less storage space.

SAFER—MORE ATTRACTIVE—self-locking via spring tension and pipe weight . . . shipped assembled, stays assembled . . . zinc-coated or copper-plated.

REDUCES LABOR COSTS—tests by industrial engineers reveal that "AUTO-GRIP" installs in only 20% of the time required for old-fashioned clevis-type rings. Universal, counterbored hanger insert secures quickly to ceiling hanger rod. Insert is adjusted easily on rod by finger strength.

HOW "AUTO-GRIP" WORKS

Squeeze together —insert drops out

Spread and slip over pipe

Squeeze— replace insert

FREE SAMPLE • TIME-SAVING DATA • MAIL COUPON TODAY!

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COMPANY_____

ADDRESS_____

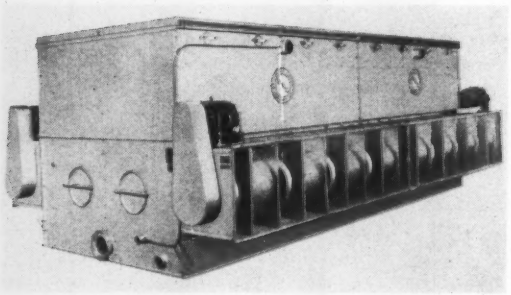
CITY_____ ZONE____ STATE_____

#160

AUTO GRIP "Auto-Grip" Division
® Box 360 • Youngstown 1, Ohio
"Automatic" Sprinkler CORPORATION OF AMERICA

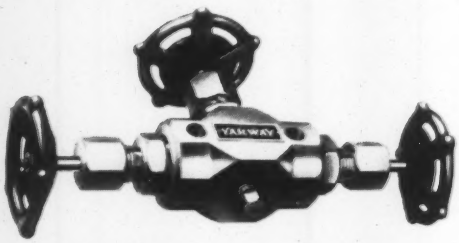
EQUIPMENT DEVELOPMENTS

Continued



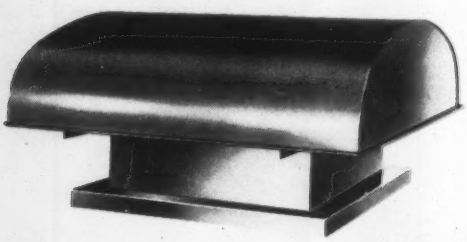
Cooling Tower . . .

. . . in three models to 700 ton capacity, feature slow speed centrifugal fans, hot-dip galvanized construction with aluminized finish; available in complete, factory assembled package; also available with axial-flow fans—*Baltimore Aircoil Co., Inc., P.O. Box 7322, Baltimore 27, Md.*



Valve Manifold . . .

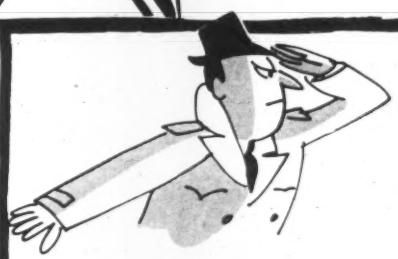
. . . for connections to flow meters, level indicators, etc., provides two shut-off and one pressure-equalizing valves in single body, with calibration connection tap; of stainless steel, furnished with screwed or socket-weld end connections; bulletin "RI-1825" available on request.—*Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.*



Roof Ventilators . . .

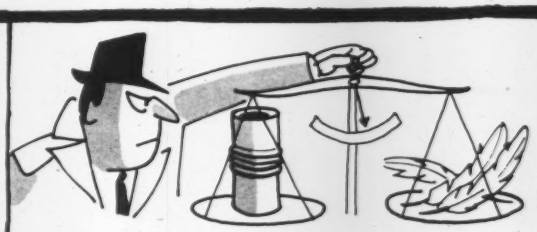
. . . in several models for relief, gravity intake, power exhaust, and power supply applications; powered units are belt or direct drive; standardized housing fits all models, features low silhouette, according to manufacturer—*Western Engineering & Mfg. Co., P.O. Box 64455, Los Angeles 66, Calif.*

HOW TO SLEUTH OUT THE TRUTH ABOUT EXPANSION JOINTS



1 **Case the joint (design, that is)**

Badger S-R Expansion Joints have: 1. Corrugations which assume "all curve" shape under pressure — low stress, long life. 2. Tubular rings allow flexing over more of corrugation height.

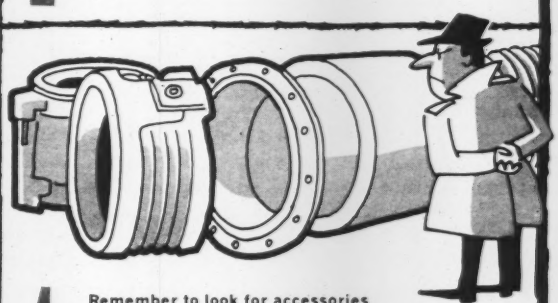


2 **"Weigh" the evidence**

S-R Joints have no bulky castings . . . weigh up to 50% less . . . diameter equivalent to pipe flange. Installation is easier, lighter supports required.

3 **Search for clues in fabrication methods**

Bellows are hydraulically formed to produce uniform corrugations with minimum thinning of material. Quality controlled longitudinal welding, no multiple circumferential welds.



4 **Remember to look for accessories**

Full line of accessories — including covers and liners. Easy to pick proper combination of model, type and accessories for any pressure, temperature, erosive or corrosive condition.

5 **Pull an M.O. on the manufacturer's background**

Badger's 50-year experience includes development of first successful self-equalizing design for higher pressures, temperatures. Badger has had more fabrication and engineering experience in more different applications than any other manufacturer.

6 **Close the case — buzz Badger**

See the Badgerman for expert help on your most exacting pipe expansion problems. He knows his business, your problems. Call or write today.

BADGER *Expansion Joints* **S·R**

BADGER MANUFACTURING COMPANY
230 Bent Street, Cambridge 41, Mass.
Representatives in Principal Cities

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RIDGID No. 205 Tubing Cutter

Time-Saving, Slide-to-Size ⅛" to 2⅜" O.D. Capacity

Made of lightweight, high-strength cast aluminum alloy, you'll find these new RIDGID Tubing Cutters extra handy. Slight push on handle of large-size-range RIDGID No. 205 snugs cutter wheel against tubing . . . locks it in position until released. Feed screw fully protected and enclosed . . . always feeds into tube with easy handle turn . . . can't jam with chips or dirt. Wheel gives quick, clean cuts of copper, brass, aluminum tubing and thin-wall conduit . . . no burr. Grooved rollers give easy flare cut-offs without tubing waste. Tubing always turns freely on 2 of 4 Rollers. Rollers smooth tubing ready for soldering. Fold-in reamer always handy. Spare Cutter wheel in handle. Wheel for plastic and aluminum pipe available for No. 205 only.

Conform to Fed. Spec. GGG-C-771b Type II—Class I—enclosed feed mechanism

RIDGID No. 105 Tubing Cutter

Protected Feed Screw
Always Easy-Turning
⅛" to 1⅛" O.D. Capacity

To save time and tubing, order these new RIDGID Tubing Cutters today! Your Supply House has them!

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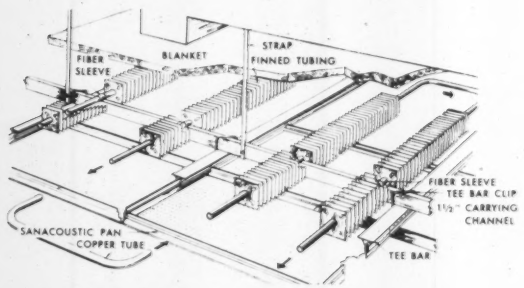
The Ridge Tool Company • Elyria, Ohio, U.S.A.

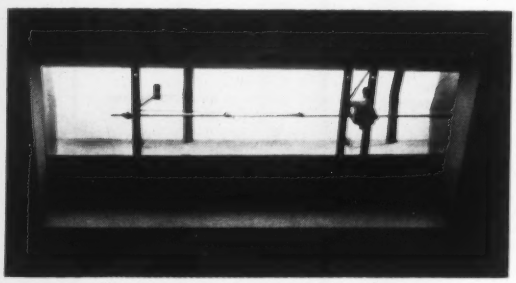
EQUIPMENT DEVELOPMENTS

Continued



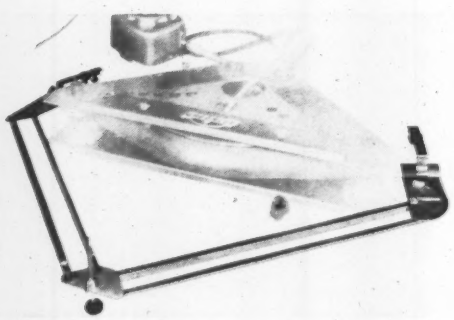
Radiant Ceiling . . .

. . . for heating and cooling by means of water-carrying coils, comprised of serpentine coils, insulating blanket and perforated metal panels for finished ceiling; may be zone or individual-room controlled; panels are snap-installed for easy access—*Johns-Manville Corp., 22 E. 40th St., New York 16, N.Y.*



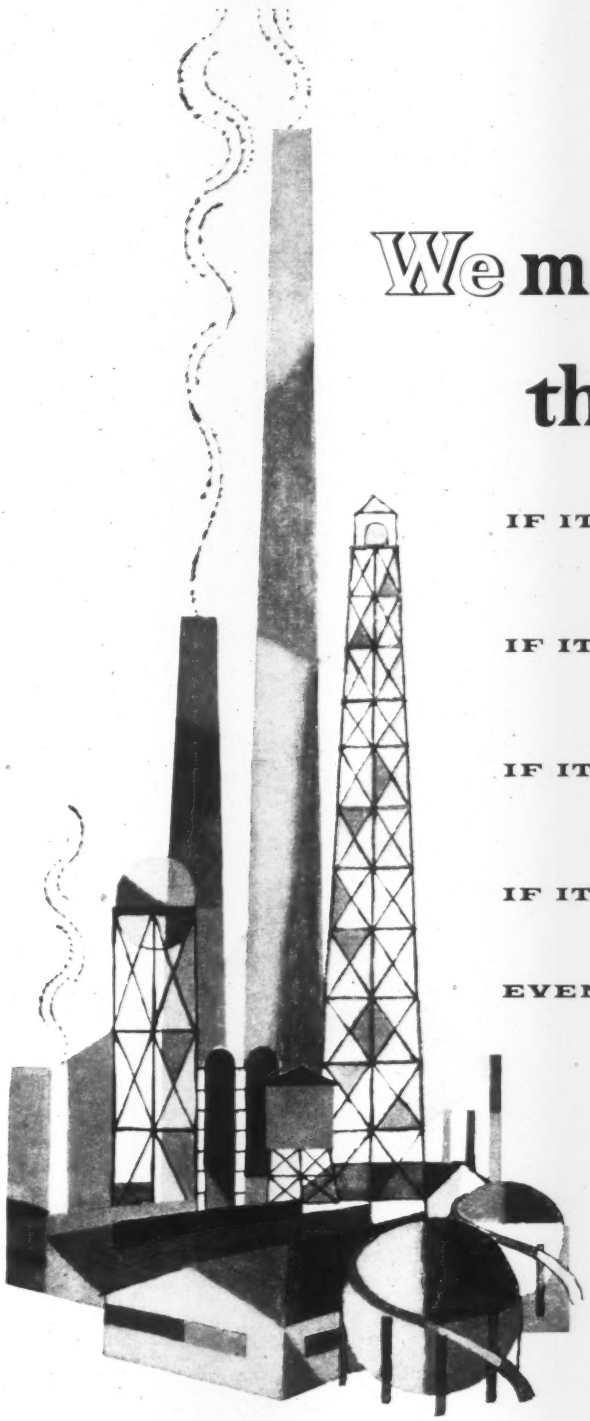
Ventilator-Skylight . . .

. . . combining gravity type ventilator and glass fiber light diffusing panels; provides natural light source with ventilator damper open or closed, according to manufacturer; can be used with automatic operating equipment and egg crate grilles—*Swartwout Fabricators, Inc., 100 East North St., Kokomo, Ind.*



Pipe Bend Indicator . . .

. . . for use with any hydraulic pipe and conduit bender operating in horizontal position, indicates degree of bend on ½ to 6 in. diameter pipe; pipe need not be removed from bender for reading; instructions supplied with indicator for accomplishment of large sweep bends—*Greenlee Tool Co., 2136 12th St., Rockford, Ill.*



We make the pumps that move it!

IF IT FLOWS... through pipelines, heat exchangers, cooling towers, evaporators, condensers, stills, boilers or other processing equipment . . .

IF IT'S LIQUID... gases, paints, molasses, lubricants, chemicals, foods, plant wastes, asphalt, fuel oils, solvents, fibrous trash or solids in slurries . . .

IF IT CIRCULATES... through cracking plants, refineries, canneries, paper mills, steel mills, packing plants, breweries, air conditioning systems or machine tools . . .

IF IT'S PUMPED... in or out of mines, sewers, construction sites, cofferdams, swamps, reservoirs or tank cars . . .

EVEN IF it's highly corrosive or volatile, viscous or non-viscous, hot or cold . . .

The Fairbanks, Morse line of pumps includes a type, size and capacity for almost any pumping requirement—and the power unit matched to drive it!

Pump sizes to 152 inches . . . capacities to 800,000 gpm . . . heads to 3000 psi.

(Electric motors that move the pumps: ½ to 10,000 hp... Generators, alternators and generator sets ½ kw to 3,500 kva.)

Fairbanks, Morse

PUMP AND HYDRAULIC DIVISION • KANSAS CITY, KANSAS

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

Life in these excited states...

"So you've got some leaks . . . look, new pipe costs money!"

Troubles coming in waves? Try Ace-Ite pipe

Ace-Ite Plastic Pipe . . . a tough, chemical-resistant ABS rubber-resin blend . . . is the surest way to stem the tide of corrosion. One of eight types of Ace pipe, it's ideal for general use, handles most chemicals. It's been around long enough so we know what it'll do. And you'll like the price. *Ask for Bulletin CE-80.*

Ace chemical-resistant rubber-lined steel pipe best for high-pressure, big sizes, or abrasives. Pipe, fittings and valves 1½ to 24".

Highly efficient *WE* pump. Capacity to 360 gpm. Cast iron, fully protected by top quality, chemical resistant hard rubber lining.

Design assistance and facilities for molding special fittings, pump parts, etc., of plastics or hard rubber. Also large hand-fabricating facilities.

Variety and quality to match *any* plastic piping. Riviclor PVC, Ace-Ite rubber-plastic, Parian poly, Ace Saran, Tempron high temperature nitrile, hard rubber-lined steel.

ACE *chemical resistant equipment*
BY **AMERICAN** HARD RUBBER COMPANY
DIVISION OF **AMERACE** CORPORATION
ACE ROAD • BUTLER, N.J.

See ACE equipment in Chemical Engineering Catalog

EQUIPMENT DEVELOPMENTS

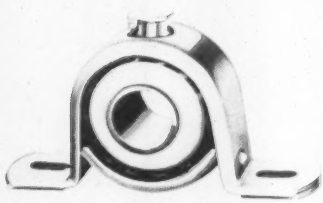
Continued

Control Panels . . .

. . . of "packaged" design for start, stop, and supervision of gas fired boilers, heaters, and heat-treating systems; panel includes starter for 3 hp motor, access door circuit breaker, flame failure safety device, control circuit transformer for 115 v, purging timer, electric ignition transformer, audible alarm, indicator lights, selector switches; 230 v 60 cycle unit is basic, other hp and electrical requirement panels available—*Protection Controls, Inc., 7317 N. Lawndale Ave., Skokie, Ill.*

Electric Motors . . .

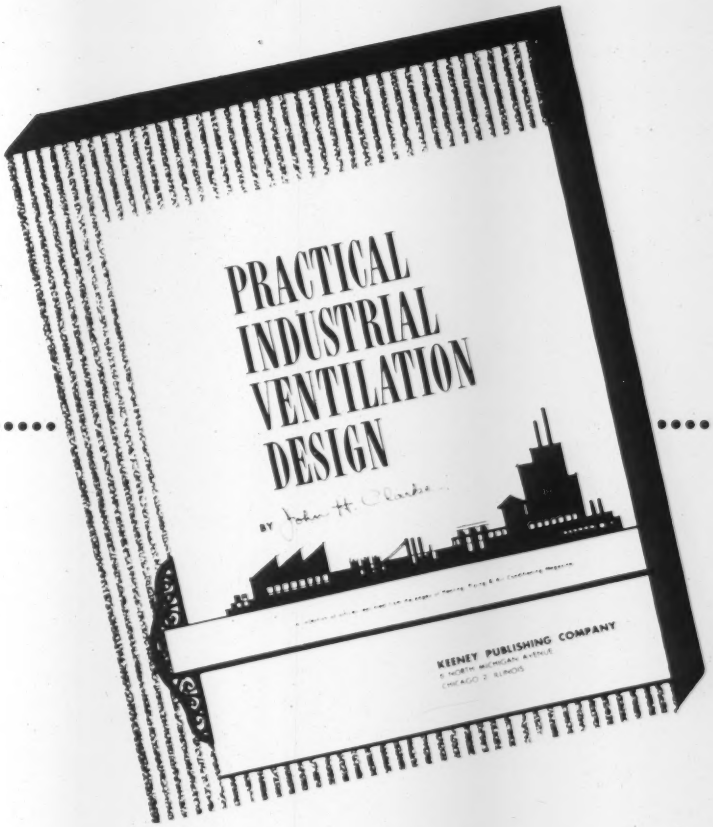
. . . 30 to 250 hp hermetic 3-phase induction, equipped with thermal overload switches in stator windings which open circuit at predetermined point or lower point under conditions of rapid temperature rise; switches are "fail safe"—*General Electric Co., 1 River Rd., Schenectady 5, N.Y.*



Pillow Blocks . . .

. . . in ¾ to 1¼ in. shaft sizes, self-aligning with 360 degree neoprene cushion; said to offer increased noise and vibration suppression advantages, line complements smaller-shaft series offered earlier—*Triangle Mfg. Co., 724 Division St., Oshkosh, Wis.*

NOW AVAILABLE IN HANDBOOK FORM!



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BY JOHN H. CLARKE

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...there's a WEINMAN to fit your exact requirements!

Typical UNIPUMP, available with threaded connection or flange; capacities to 2000 GPM; heads to 260 ft.

For the solution to any pumping problem you can depend on Weinman pump specialists. You can depend on every Weinman installation, too, for the efficient, low-cost operation you want.

Weinman's complete line of dependable, general service Unipumps, with capacities to 2000 GPM, are built to handle man-sized pumping jobs in a minimum of space. Ideal for air conditioning installations, Unipumps operate efficiently from any position for continuous, maintenance-free service.

For multiple pump installations Weinman experts work closely with heating and plumbing engineers to meet precise job specifications. An outstanding example is the 12-pump Weinman installation (illustrated below) at the ultra-modern headquarters for Columbus and Southern Ohio Electric Company, Columbus, Ohio. An integral part of one of the world's largest electric air source heat pump installations, built by York Division, Borg-Warner Corporation, Weinman pumps provide vital control of the flow of hot and chilled water through the heating and air conditioning systems of this nine story building. The reason is simple — as specialists in the design and development of centrifugal pumps — Weinman builds to precise requirements.

You'll find your local Weinman Pump Specialist listed in the Yellow Pages. Or, if you want further information, write to us.

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290 SPRUCE STREET COLUMBUS 15, OHIO
CENTRIFUGAL SPECIALISTS

EQUIPMENT DEVELOPMENTS
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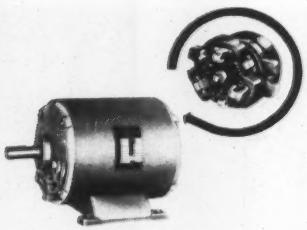
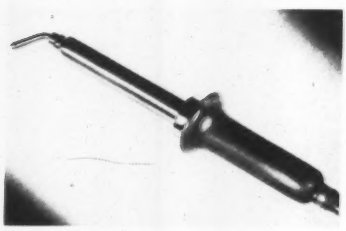


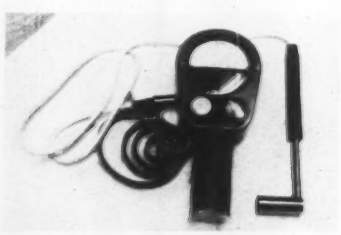
Electric Motors . . .

. . . 3-phase, 1/4 through 3 hp a-c in 67 types with variety of voltages, speeds, mountings; feature integral temperature and current safety cut-outs, for pump and air conditioning applications; bulletin "M-1986A" available on request—*Howell Electric Motors Co., Kingston-Conley Div., 900 North Ave., Plainfield, N.J.*



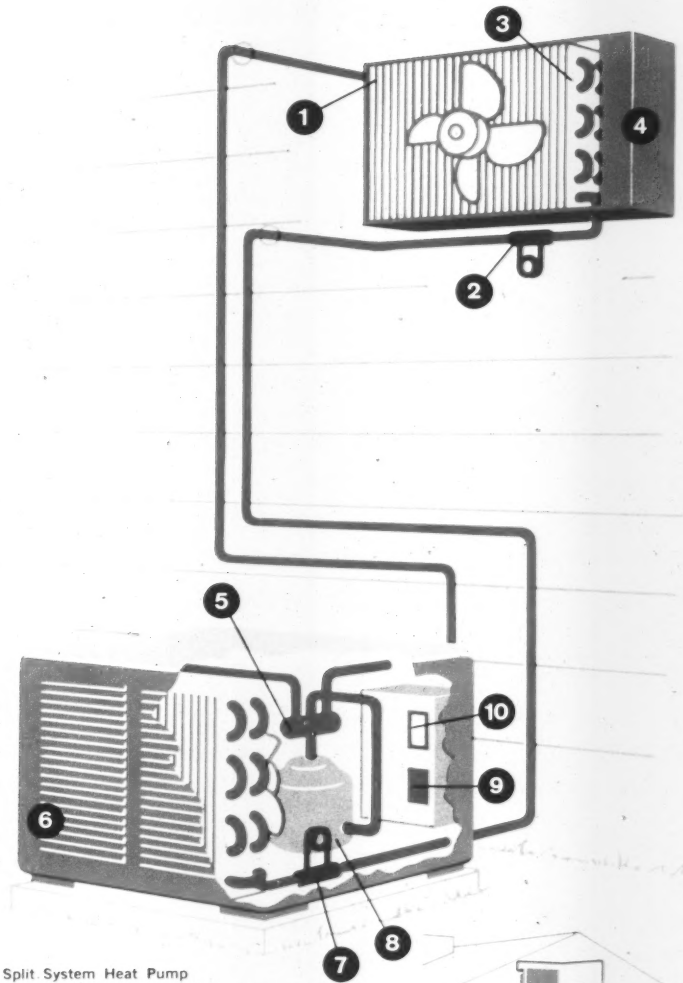
Welding Torch . . .

. . . for use on structural plastics is constructed of stainless steel with glass fiber handle; with 350 w 110 v heating element; total weight 11 oz., furnished in metal carrying case or in kit with various accessories—*Laramy Products Co., Cohasset, Mass.*



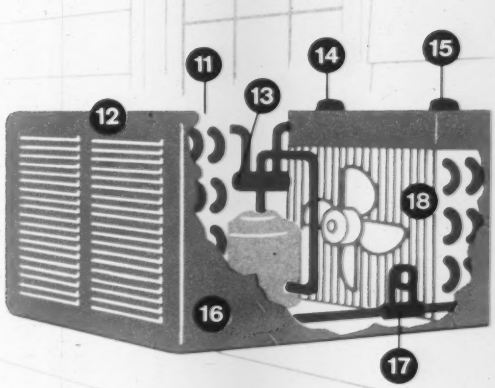
Hot-Wire Anemometer . . .

. . . measures air velocity in 0.05 to 30 ft per second range, air temperature in 30 to 110 F or 50 to 250 F ranges; battery powered, with probe containing two wires arranged in wheatstone bridge circuit; supplied with carrying case—*Gelman Instrument Co., 106 N. Main St., Chelsea, Mich.*



Split System Heat Pump

1. Evaporator Protector D60
2. Restrictor Valve V51
3. Fan Limit A10
4. Auxiliary Heater A24
5. Reversing Valve V25
6. Pan Heater A11
7. Restrictor Valve V51
8. Crankcase Heater A11
9. Hi-Lo Pressure G
10. De-Icer D52



Window Unit Heat Pump

11. De-Icer D50
12. Auxiliary Heater A24
13. Reversing Valve V26
14. Stage Control C21-C22
15. Selector Switch S40
16. Pan Heater A11
17. Restrictor Valve V50
18. Evaporator Protector D60

Automatic Heat Pump Controls by Ranco

Designed for practical applications, Ranco controls are the most complete and advanced line in the industry, help you take full advantage of the growing market for heat pumps. These new heat pump controls and valves, pioneered by Ranco make heat pump operation automatic and simple for both window-type units and central heating-cooling systems.

The wide line of Ranco controls for heat pumps includes de-icing controls, slide-type reversing valves, and automatic cycling controls. Their practical design permits broad adaptation, plus operation in a wide geographical area. Thorough testing under all types of conditions in laboratory and field assures top performance and dependability.

More than 100,000,000 Ranco Controls now in use

Ranco® INCORPORATED
COLUMBUS 1, OHIO

For additional information on the practical application of heat pump controls, contact Ranco today.

CHICAGO SUN-TIMES

Naess & Murphy
Architects-Engineers

Field Enterprises, Inc.
Owners

George A. Fuller Company
General Contractors

William A. Pope Company
Refrigeration Contractors

Kroeschell Engineering Co.
Heating Contractors

New completely air conditioned building ... last word in comfort and efficiency

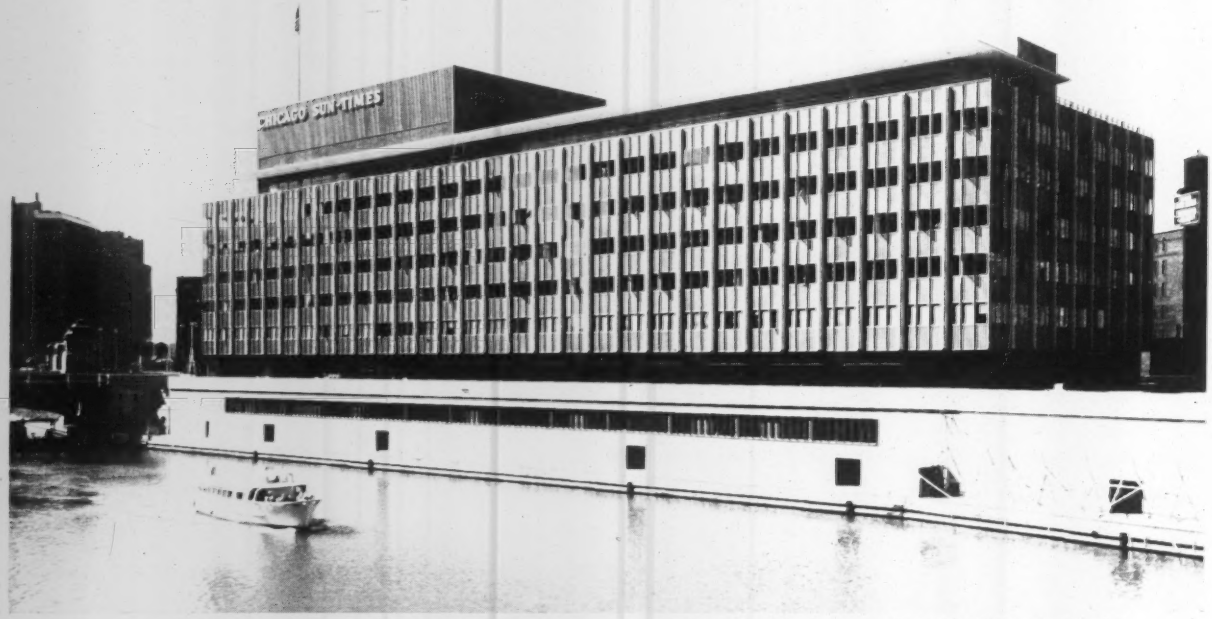
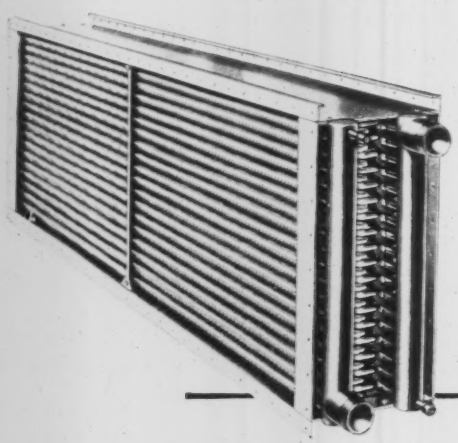


Photo: Hedrich-Blessing, Chicago

AEROFIN INSTALLED



Aerofin's modern SMOOTH FIN design permits use of high air velocities without turbulence or excessive resistance — provides ample heat-exchange capacity in limited space.

You can safely specify Aerofin coils at full published ratings. Aerofin performance data are laboratory and field proved by the pioneers in light-weight extended surface.

AEROFIN CORPORATION

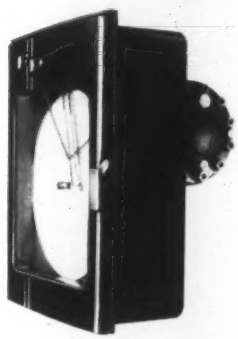
101 Greenway Ave., Syracuse 3, N. Y.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

ENGINEERING OFFICES IN PRINCIPAL CITIES

EQUIPMENT DEVELOPMENTS

Continued

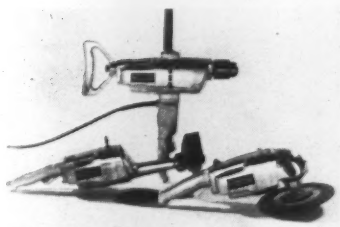


Flowmeter . . .

. . .bellows type, for measuring differential pressure in inches of water from 0 to 20 up to 300; indicating and/or recording instrument can be equipped with controller, totalizer, pneumatic or electric transmitter plus additional pressure and temperature indicators and pens; metal meter body self-venting and self-draining, rated at 2000 and 5000 psi in steel and stainless steel—*Fischer & Porter Co., 471 Jacksonville Rd., Warminster, Pa.*

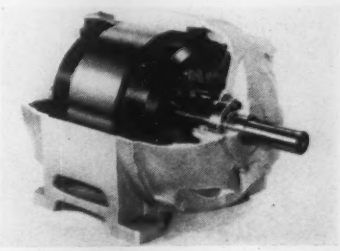
Caulking Compound . . .

. . .said to be suitable for caulking pipe joints, seams, ductwork; also to weld without heat wide variety of dissimilar materials including metal, wood, plastic, fabric; of epoxy resins plus fillers, is used with activator catalyst to provide joining material up to 2 in. thick; manufacturer states compound yields compressive strength of 18,000 psi, tensile strength 12,000 psi, tensile shear 3,000 psi; unaffected by temperature variation, available in neutral or any color on request in bulk lots—*Adams Chemical Corp., 120 Center St., El Segundo, Calif.*



Portable Tools . . .

. . .electric, including ½, ¾, and 1¼ in. drills, 7 and 9 in. disc sanders, 7 in. polisher, 5 and 6 in. portable grinders; feature new fan for high-speed airflow through housing, sealed trigger switches, "window" brush holders—*Stanley Electric Tool Div., The Stanley Works, 195 Lake St., New Britain, Conn.*

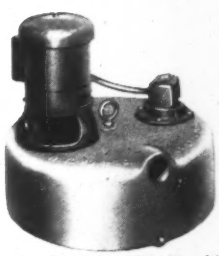


Electric Motors . . .

. . .featuring epoxy-resin insulated windings for adverse environment operation available in manufacturer's full line; offer increased protection against moisture, acids, gases, alkali or caustic conditions, abrasives, other contaminants; bulletin "F-1995" available on request—*U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.*

Low Return *Condensate Pumps*

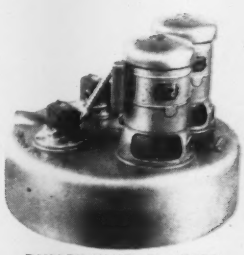
Capacities 500 to 15,000 sq. ft. E.D.R.



SINGLE UNIT—Fig. 302A
10 Gal. Receiver for Single Units
Diameter 21"
Hgt. of Return above floor 6⅞"

weil TVC PUMP

LOW RETURN CONNECTION
LOW SPEED, LONG LIFE
CAST IRON RECEIVER
LOW WATER LINE
FLOAT SWITCH CONTROL



DUPLEX UNIT—Fig. 303B
15 Gal. Receiver for Single or Duplex Units
Diameter 25½"
Hgt. of Return above floor 7³⁄₁₆"

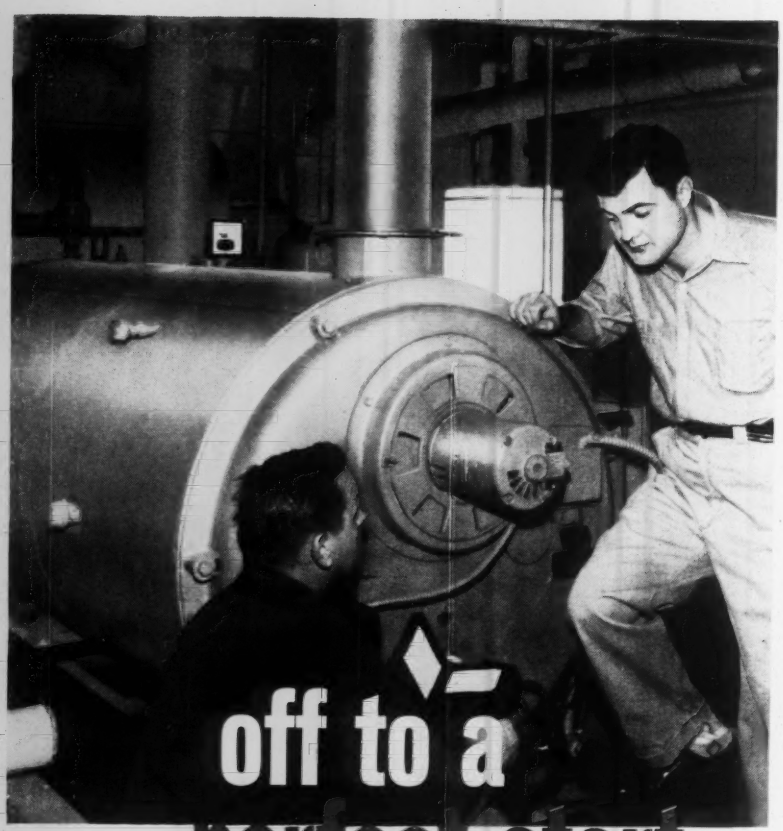
Unit Number	Max. Sq. Ft. Direct Radiation	Disch. Press. In Lbs. At Pump	GPM Radiation Will Condense	Capacity of Pump in GPM	Motor H.P.	Return Inlet in Inches	Pump Discharge in Inches	Diameter and Capacity of Receiver	Height of Return to Centerline
TVC-19	750	20	.38	1.5	¼	2	1	21" -10 Gal.	6⅞"
TVC-23	1000	20	.5	1.5	¼	2	1	21" -10 Gal.	6⅞"
TVC-29	2000	20	1.0	3.0	¼	2	1	21" -10 Gal.	6⅞"
TVC-35	4000	20	2.0	6.0	¼	2	1	21" -10 Gal.	6⅞"
TVC-41	6000	20	3.0	9.0	⅓	2	1	21" -10 Gal.	6⅞"
TVC-47	8000	20	4.0	12.0	½	2	1	25½"-15 Gal.	7³⁄₁₆"
TVC-52	10000	20	5.0	15.0	¾	2	1	25½"-15 Gal.	7³⁄₁₆"
TVC-54	15000	10	7.5	22.5	½	3	1¼	25½"-26 Gal.	10½"
TVC-55	15000	20	7.5	22.5	¾	3	1¼	25½"-26 Gal.	10½"
TVC-56	15000	30	7.5	22.5	1	3	1¼	25½"-26 Gal.	10½"
TVC-57	15000	40	7.5	22.5	1½	3	1¼	25½"-26 Gal.	10½"

Intermediate Sizes Based Upon Discharge Pressure Required Are Available.

See Bulletin TVC-300 for Full Specifications

See Catalog in Sweet's and Domestic Engineering Catalog Directory

weil PUMP COMPANY • 1514 N. Fremont St. • Chicago 22, Illinois



off to a perfect start

Cleaver-Brooks starting service sends Progress packaged boilers off to a right start . . . assures tip-top boiler performance . . . greater customer satisfaction.

This unique starting service is typical of many extra values you enjoy when you install America's finest commercial heating boiler . . . more evidence of Cleaver-Brooks undivided responsibility for boiler performance.

1. Every Progress boiler is started by a trained Cleaver-Brooks serviceman. He adjusts it carefully for fuels and loads on job site. This means fewer hours on the job for you . . . less cost . . . fewer call backs. It means superior performance, more satisfied customers.
2. Cleaver-Brooks serviceman trains the boiler attendant . . . instructs him in the care and operation of the boiler. This relieves you of the time and cost of this important follow-up responsibility.

Other important profit-making advantages in the Progress packaged heating boiler: packaged design, fully factory-tested, ready to install on the job site. Clean, quiet operation. High efficiency: 80% guaranteed. Hinged doors simplify maintenance.

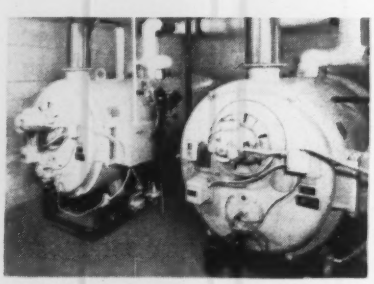
Built by America's largest builder of packaged boilers.

Cleaver-Brooks Progress Boilers—seven sizes to 2,010,000 Btu.—for all types of commercial heating with oil, gas or combination oil/gas. Write: Dept. F, 313 E. Keefe Ave., Milwaukee 12, Wis.

Cleaver Brooks®

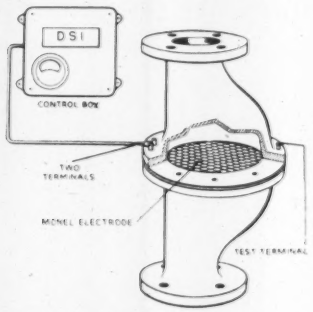
Progress

Packaged Heating Boiler



EQUIPMENT DEVELOPMENTS

Continued



Scale Inhibitor . . .

. . . consists of expanded pipe section containing grid electrode plus remote control box, for ½ to 8 in. pipe sizes, 100 to 40,000 gph capacities, with larger sizes to order; for preventing scale formation in water systems, low pressure steam generators, etc., operates on a-c current or 1½ v dry cell; supplied with threaded ends on 1½ in. sizes and below, flanged ends on 2 in. and larger; precipitates salts, preventing crystallization and scale build-up, according to manufacturer —*Dehydrosal Systems, Inc., 521 Fifth Ave., New York 17, N.Y.*

Chlorinator . . .

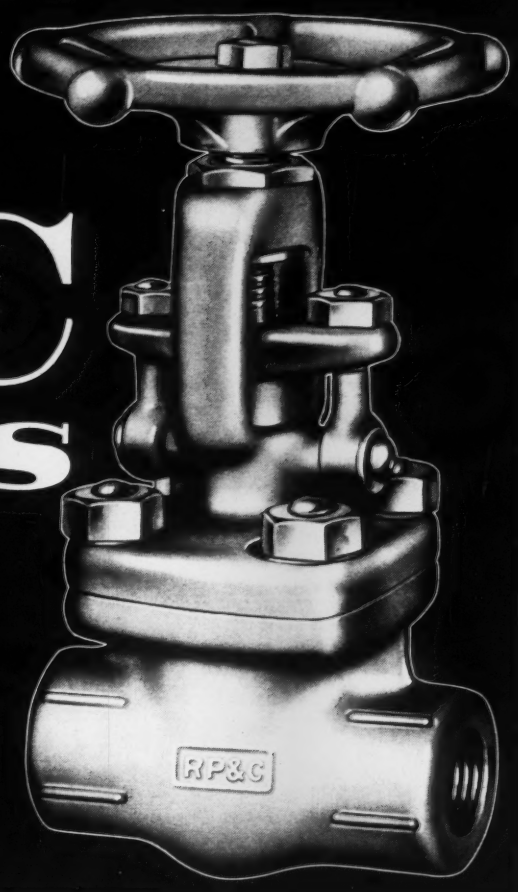
. . . provides manual or automatic control over 0.1 to 2000 lb per day capacity range; automatic models accept electric, pneumatic, or vacuum signals from any type metering device for proportional, start-stop, program, multiple rate, or residual control feed; cabinet, piping, working parts made of plastic and alloys.—*Fischer & Porter Co., 467 Jacksonville Rd., Warminster, Pa.*

ACCO
for Better Values

THE COMPLETE LINE—

R-P&C VALVES

DESIGNED FOR DEPENDABILITY



This new FORGED STEEL GLOBE VALVE offers maximum strength and safety...longer life!

• R-P&C's new F80 Forged Steel Globe Valve is a versatile, precision-built addition to a distinguished valve family. Designed and engineered in cooperation with many of the country's leading engineers of the power, process piping and shipbuilding industries, the F80 Globe Valve is manufactured to the most rigid standards to overcome the problems of ever-increasing temperatures, pressures and corrosion.

Here are a few of its many features that insure greater strength and safety, longer service life and lower maintenance cost: Forged Steel body, bonnet and gland..."375 Brinell" stem with rolled stem threads..."500 Brinell" disc-lapped seat face...molded, reinforced asbestos packing. Test Pressures: Hydrostatic Shell test, 2500 P.S.I....Seat Test (air under water), 100 P.S.I....Pneumatic Testing at 300 P.S.I. when specified. For details, *write for Folder DH-213.*

R-P&C offers a Complete Line

• Look to your R-P&C Distributor for R-P&C gate, globe, angle and check valves—in bronze, electric iron, cast or forged steel—in a wide range of styles, sizes and pressure classes. In addition, R-P&C offers a full line of cast steel fittings, also specialties such as asbestos-packed cocks, bar stock valves, Lubrotite gate valves and other items. For complete R-P&C catalog, write our Reading office.

BAR STOCK VALVE

BRONZE GATE VALVE

IRON GLOBE VALVE

FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO
TRADE MARK

800 to 1 hp favorites for quiet operation, low maintenance and long-life service . . .

From the case of the A. O. Smith Motor Man — a complete stable of integrals that include single-phase models (1-5 hp) or polyphase (1-800 hp). Also a team of fractional-hp motors. All are sure bets to give top performance over the long, long haul.

And there's an A. O. Smith Motor Man near you — chomping at the bit to give you 24-hour action on all parts and service orders.

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Through research ... a better way

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Milwaukee 1, Wisconsin, U.S.A.

Another
EXTENSIVE PIPING SYSTEM
Protected by
Williams-Hager
Silent
CHECK VALVES

The new building of the *First National Bank of Minneapolis* is another significant structure safe from water hammer damage and annoyance . . . through use of *Silent* Check Valves.

Write for Bulletins: No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer.

Architect & Engineer: Holabird & Root, Chicago
General Contractor: Naugle-Leck, Inc., Minneapolis
Mechanical Contractor: Bjorkman Brothers Co., Minneapolis
Air Conditioning Contractor: Commercial Air Co., Minneapolis

The Williams Gauge Co., Inc.
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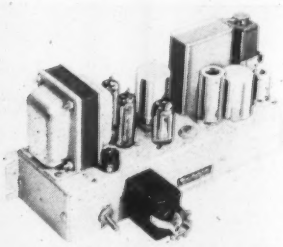
EQUIPMENT DEVELOPMENTS
Continued

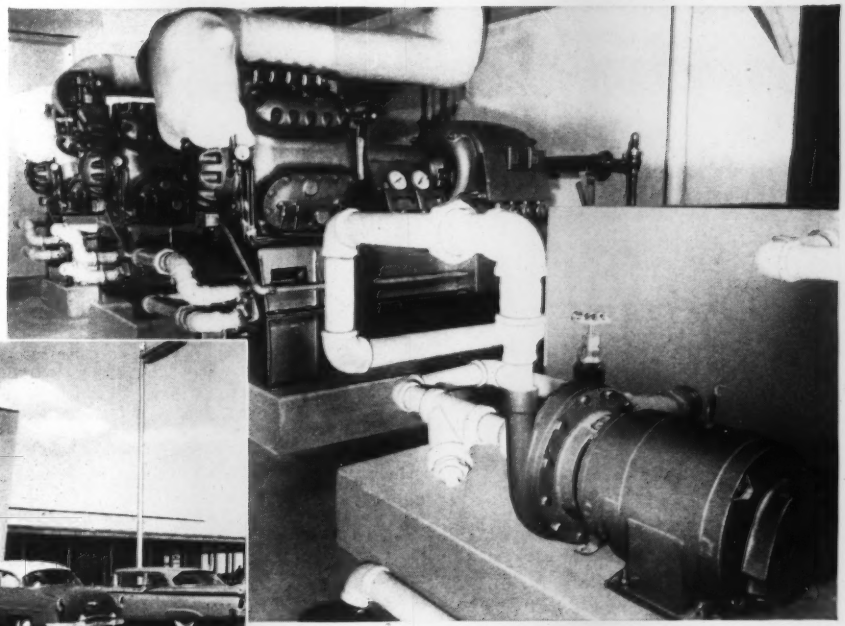
Power Hammer . . .

. . . for setting ¼ or ⅜ in. diameter steel fasteners, employs .22 or .25 caliber powder charges; in 2 models: one for ¼ in. studs, second with interchangeable ¼ and ⅜ in. barrels; both models accommodate fasteners from 1 to 6 in. in length; said to be capable of driving up to 6 fasteners per minute — *Gregory Industries, Inc., Nelson Stud Driver Div., Lorain, O.*



Servo Amplifier . . .

. . . for use in industrial process control systems, sensitive to 3 microvolt input signal change with ±2 microvolt stability, according to manufacturer; adapts to control instrumentation application wherein transducer produces voltage or resistance change; unit accepts low-level d-c input with positive polarity, converts signal to a-c and transmits amplified signal to servo motor; operates on 117 v 50 to 60 cycle power—*Thermo Electric Co., Inc., Saddle Brook, N.J.*



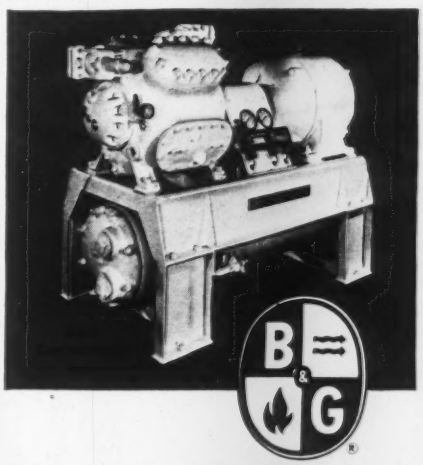
INDIANA TOLL ROAD *INTERSTATE* HOSTS *Commissary*

COOLED BY B&G® CONDENSING UNITS

Three low temperature B&G Condensing Units handle the refrigeration requirements of this well known restaurant chain unit at Elkhart, Indiana.

B&G Condensing Units offer a completely capacity-engineered combination of B&G Chassis, B&G Motor, B&G Compressor, B&G Condenser and automatic capacity control. B&G builds *all* these components into a unit specifically designed to meet the requirements of the installation.

Exceptionally rugged construction and low center of gravity assure damage-free installation. Bell & Gossett refrigeration equipment, as in all of its many products, is built to provide years of dependable service—always ready to meet the challenges of unusual conditions.



BELL & GOSSETT
COMPANY
Dept. RGE-5, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd.
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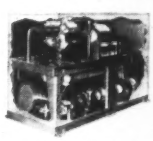
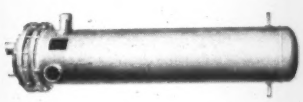
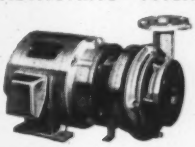
A COMPLETE LINE OF REFRIGERATION AND AIR CONDITIONING "PACKAGES" AND COMPONENTS



B&G Package Liquid Coolers



B&G Evaporators

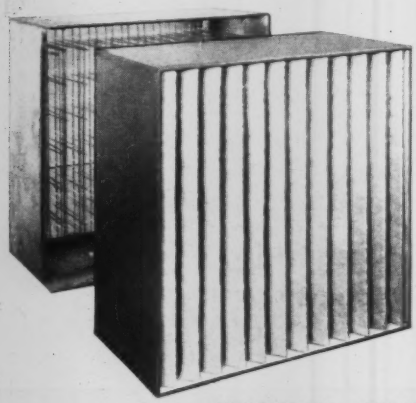


B&G Centrifugal Pumps

B&G Condensers

The Cambridge AEROSOLVE® Filter is the RELIABLE Filter

- High Efficiency
- Positive Filtration
- Low Pressure Drop
- Easy Installation & Maintenance
- High Velocity — 450 FPM
- Expert Technical Assistance



Be specific about filter efficiencies

Compare!

EFFICIENCY — STANDARD TESTS

TYPE FILTER	WEIGHT TEST (Synthetic Dust)	NBS TEST # METHOD (Atmospheric Dust)	DOP TEST (0.3 Micron Smoke)
Cambridge ABSOLUTE®	*	*	**99.97 Min.
Cambridge MICRETAIN	*	99	95
Cambridge AEROSOLVE® 95	*	90-95	80-85
Cambridge AEROSOLVE 85	99	80-85	50-60
Cambridge AEROSOLVE 35	96	30-35	20-30
Electronic Precipitator	99	85-90	60-70
Pleated Paper	94	25-30	15-20
2" Cleanable	76	8-12	2-5
2" Throwaway	76	8-12	2-5

*Practically 100%. Test not practical for more accurate reading.
#National Bureau of Standards Discoloration Test.
**Maximum Allowable Penetration of Dioctyl Phthalate Smoke 0.03%. Every filter individually tested.

Cambridge AEROSOLVE cartridges of 95%, 85% and 35% efficiency are all interchangeable for easy adjustment to future efficiency requirements.

Write for Bulletin 132

Cambridge® Filter Corporation
732 E. Erie Blvd., Syracuse 1, N. Y.

Pioneers in High Efficiency Air Cleaning

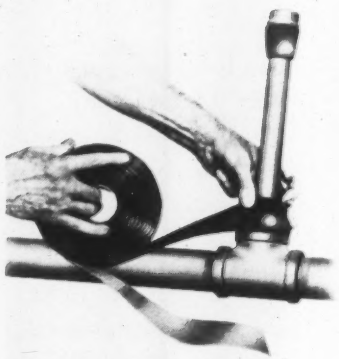
REPRESENTATIVES IN PRINCIPAL CITIES

EQUIPMENT DEVELOPMENTS

Continued

Thermometers . . .

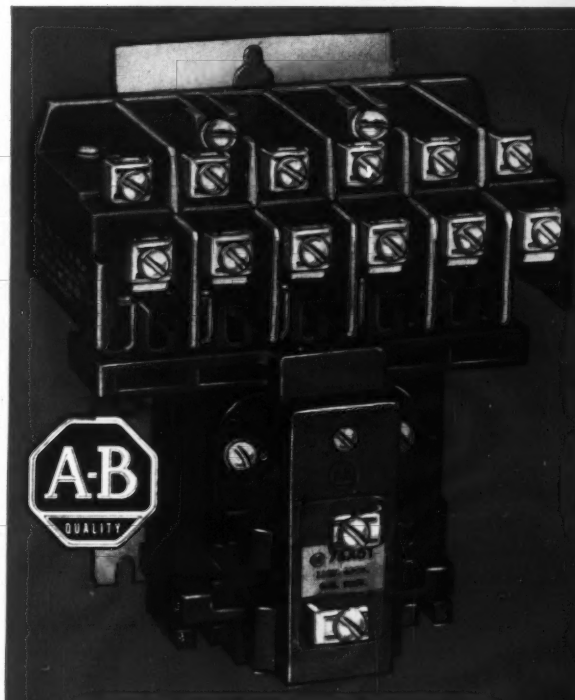
. . . in two temperature ranges: −40 to +110 F, or 30 to 240 F; with ½ in. brass sockets or 2 in. brass extension socket for use on insulated lines; available with straight, regular angle, or oblique cases; manufacturer states line is economical due to initial low cost—*H.O. Trerice Co.*, 1420 *W. LaFayette, Detroit* 16, *Mich.*



Molding Tape . . .

. . . designed as permanent conformable filling for use beneath standard pipe wrapping tapes for reducing sharp angles, build-up over welds, etc; of butyl compound, tape does not harden, shapes to wrapped surfaces, provides moisture barrier and electrical insulation, according to manufacturer; 0.045 in. thick tape available in 50 or 100 ft, 2 in. wide rolls or in wedge shapes for special order—*West American Rubber Co.*, 410 *North Ave.* 19, *Los Angeles, Calif.*

IT'S NEW



Bulletin 700 Type BR Relay with all six of the convertible poles arranged for normally open contact operation.

Allen-Bradley Convertible Contact CONTROL RELAY

BULLETIN 700

TYPE BR

Changeover made in seconds!

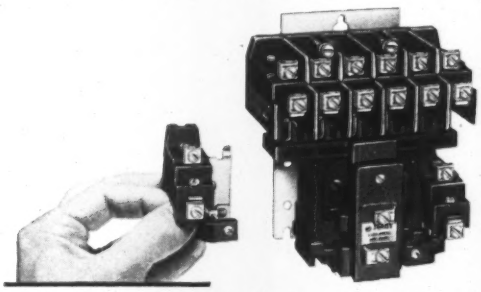
The contacts of the new Type BR relay can be arranged for either normally open or normally closed operation—and any changeover in the field can be made in seconds. A screwdriver is all that's needed.

This new A-B Bulletin 700 Type BR relay is ideal for use on automatic machines where control functions are frequently altered to meet production changes.

Quick convertibility of the contacts enables easy "on-the-spot" changes—from "normally open" to "normally closed"—or vice versa.

These new Bulletin 700 Type BR relays have been exhaustively tested to make sure that they will provide the many millions of trouble free operations for which all A-B controls are famous. In fact, the Bulletin 700 Type BR relays will establish new standards for long relay life and "reliability" of contact operation. Of course, they have double break, silver contacts that never need attention; also, the molded coil is impervious to the most severe atmospheric conditions.

Please write for full details, today!



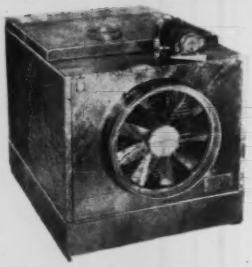
Two extra convertible poles can be easily added—in the field

An auxiliary convertible contact pole—having full switching capacity—can be easily added to the left and right sides of the Type BR relays. These auxiliary poles are front-mounted and can be added without disturbing the wiring of the relay—and without removing the relay. All relays are designed to also accept stab connectors, and—all terminals are accessible from the front.

Allen-Bradley Co., 1335 S. First St., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

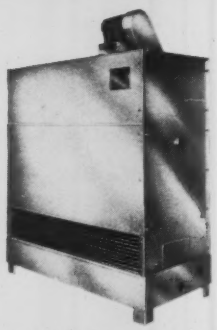
ALLEN-BRADLEY QUALITY MOTOR CONTROL

it's MARLEY for



AQUATOWERS®

World's best-known steel mechanical draft cooling towers. Heavy-duty mechanical equipment, close-packed filling cube, exclusive diffusion deck and hot dip galvanized finish result in unequalled performance, economy and durability. 14 models from 3 tons up; dual units extend capacities to 120 tons nominal.



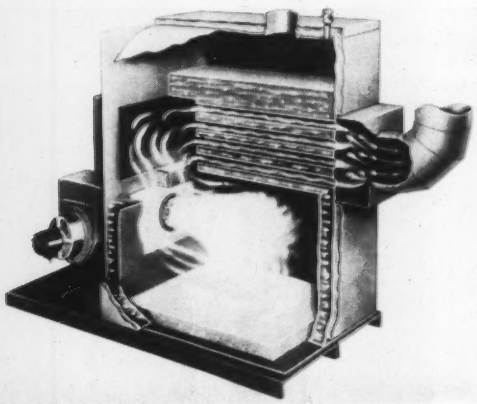
AQUACOOLERS®

Indoors or out, in minimum plan area, AquaCoolers can be easily and economically installed. Performance is full-capacity; operation is whisper-quiet and leakproof. Heavy gauge steel casings and basins, as well as centrifugal blowers and scrolls, are hot dip galvanized for extra service life. 10 models available, 5 to 90 tons, nominal.

OTHER MARLEY PRODUCTS:
SPRATOWERS® . . . for natural draft cooling
WOOD AQUATOWERS® and PERMATOWERS® . . . for longest life in corrosive atmospheres
DRICOOLERS® . . . air cooled refrigerant condensers

EQUIPMENT DEVELOPMENTS

Continued

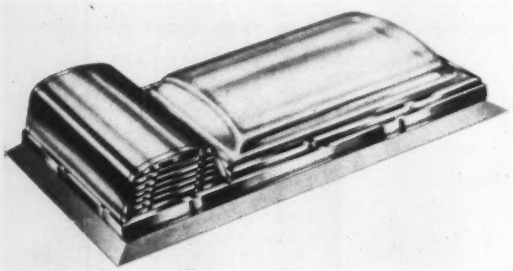


Packaged Boiler . . .

. . . with integral burner for 396,000 to 1,800,000 Btu per hr output, gas or oil fired for steam or hot water requirements of 6000 to 60,000 sq ft EDR; features pressure firing, low headroom requirements, non-refractory combustion chamber; said to operate at efficiencies of 80 percent without chimney due to sealed combustion system—*Petro*, 3170 *W*. 106 *St*., *Cleveland* 11, *O*.

Air Filters . . .

. . . for protection of miniaturized, ventilated electronic equipment in any rectangular size and thickness from ½ to 4 in., in aluminum, steel, bronze, and stainless steel; permanent type unit offers protection against dust and entrained water, oil, etc mist and is not affected by climatic or temperature changes, according to manufacturer—*Air Filter Corp*., 4518 *W*. *Woolworth Ave*., *Milwaukee* 18, *Wis*.

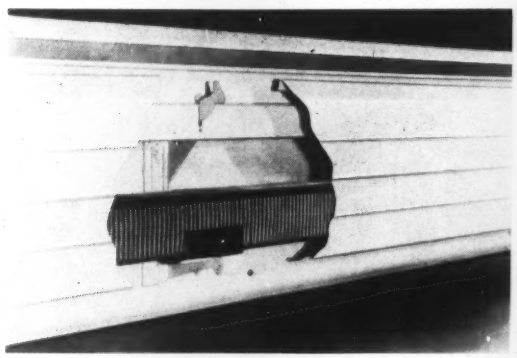


Ventilator-Skylight . . .

. . . combines 180 to 4400 cfm ventilator with clear or transluscent dome, for commercial and industrial use; ventilator has integral back-draft damper mounted inside casing; both housings mounted on single aluminum frame for easy installation; bulletin "60-LV" available on request—*Jenn-Air Products Co., Inc*., 1102 *Stadium Drive, Indianapolis, Ind*.

EQUIPMENT DEVELOPMENTS

Continued

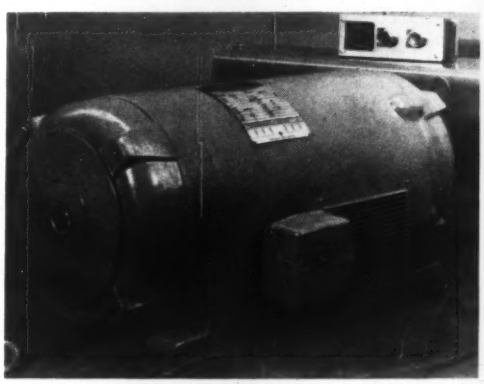


Baseboard Radiation Heater . . .

. . . for hydronic systems, features aluminum finned, copper tube element, steel housing with snap-on cover; hanger arrangement said to provide for thermal expansion and contraction by allowing element to slide back and forth; units can be connected in series for single or multiple circuits—*Hydrotherm Inc., Clinton Ave., Northvale, N.J.*

Pressure Hose . . .

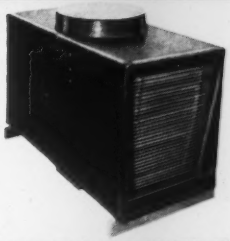
. . . for hydraulic and pneumatic applications, available in sizes 3/16 in. ID through 3/8 in. ID in 1/16 in. increments; of polyamide inner core, braided synthetic covering and plastic outer covering; said to be light in weight, flexible, applicable for wide variety of fluids including refrigerants and to meet SAE specification 100R1; available with fittings—*Samuel Moore & Co., Synflex Products Div., Mantua, O.*



Adjustable Speed Drives . . .

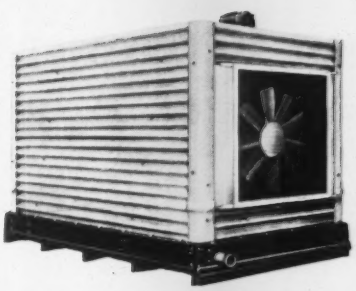
. . . offered in 1/4 to 100 hp integral-unit or separate motor models to 700 hp; drive speed may be adjusted before or during operation; tachometer-monitored controls provide speed regulation accurate within ± 2 percent of top speed, according to manufacturer; smaller drives are air-cooled, larger sizes liquid-cooled; all operate on a-c current—*Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.*

it's MARLEY for



PERMATOWERS®

Permatowers offer permanent performance in *any* climate, due to liberal use of inert materials. They also afford a wide latitude in location because air discharge is vertical . . . operation is remarkably quiet . . . and they are virtually immune to corrosion. Performance and simplicity result from famous Double-Flow® design. 11 models in capacities ranging from 5-75 tons, nominal.



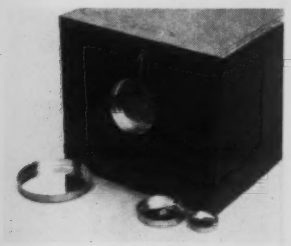
WOOD AQUATOWERS®

Forced draft design with vertical air discharge permits installation in confined areas often unsuitable for other towers. Longer service life under the most rigid operating conditions is assured by framework of lifelong redwood, asbestos cement board casing, and hot dip galvanized steel components. 5 models available with nominal capacity of 20-50 tons.

OTHER MARLEY PRODUCTS:

SPRATOWERS® . . . for natural draft cooling
STEEL AQUATOWERS® . . . for mechanical draft cooling
AQUACOOLERS® . . . for service indoors or out
DRICOOLERS® . . . air cooled refrigerant condensers

EQUIPMENT DEVELOPMENTS
Continued

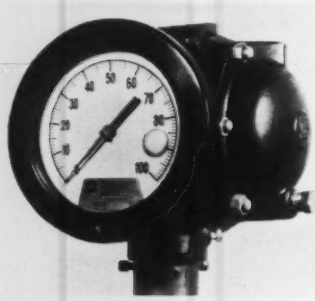


Air Flow Switch . . .

. . . actuated by predetermined air velocity, for use in air conditioning, heating applications to switch motors, solenoid valves, relays, operate alarm or interlock systems; for 15 amp, 125/250 v a-c; 5 amp, 30 v d-c—*Era Engineering, Inc., 1009 Montana Ave., Santa Monica, Calif.*

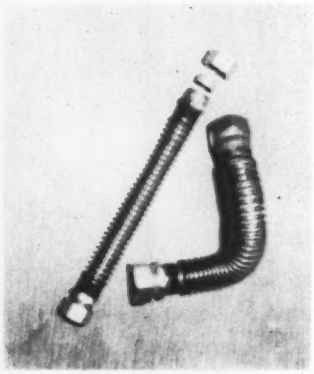
Solder Kit . . .

. . . contains 16 varieties of soldering chemicals including fluxes, solder paste, flux and dross removers, printed circuit coatings plus 11 types flux-filled and solid wire solders and 3 foil solders; supplied in wooden kit, with flux finder guide and solder selector chart—*Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.*



Bellows Meter . . .

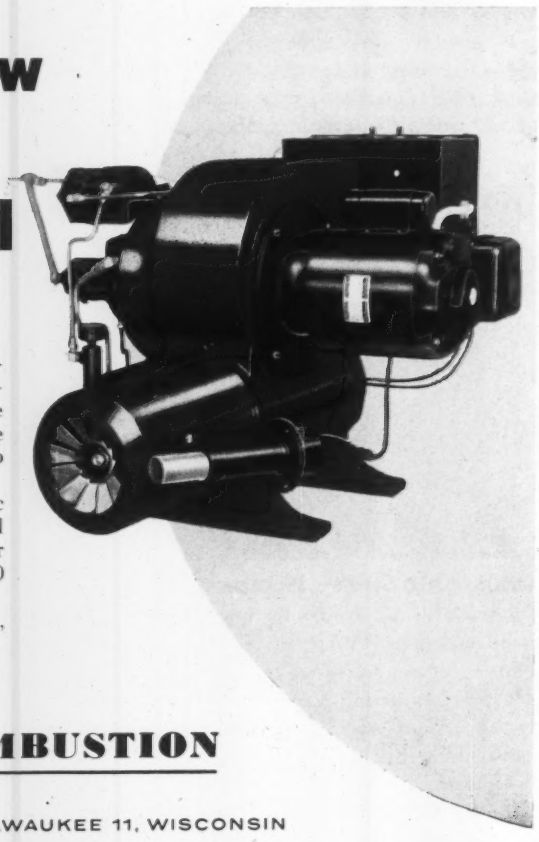
. . . for indicating steam, air, gas, water volume in 15 differential ranges from 0 to 20 in. up to 0 to 400 in. water; non-recording, non-transmitting, with calibrated accuracy of ±1 percent for 0 to 50 in. water ranges, ±1¼ percent for range below 0 to 50 in. water; has stainless steel pointer pinion, nylon-faced gear sector; may be calibrated without removing dial—*Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*



Pipe Coupling . . .

. . . for use in repairing copper pipe leaks, consists of compression fittings and flexible metal tubing; coupling can be bent to two 90 degree elbows if required; in 2 sizes: ½ in. ID hose with ⅝ in. OD fittings or ¾ in. ID hose with ⅞ in. OD fittings, for working pressures to 150 psi.—*M & R Development Co., Box 1165, Topeka, Kans.*

Keep heating costs low with HEV-E-OIL commercial-industrial burners



Hev-E-Oil burners furnish all the air necessary for combustion, assuring perfect fire control under all weather conditions. Low fire start that builds up gradually to the flame size required means smooth, safe operation. And once the burner is set for greatest efficiency, it *stays* that way no matter what the weather.

A complete package! Fire tested! Automatic, electronic controls. Meets all codes. Easy to install . . . Hev-E-Oil models from 5 to 150 gph. Also available, Hev-E-Duty power gas burners and combination gas/oil burners from 720,000 to 21,000,000 B.T.U.

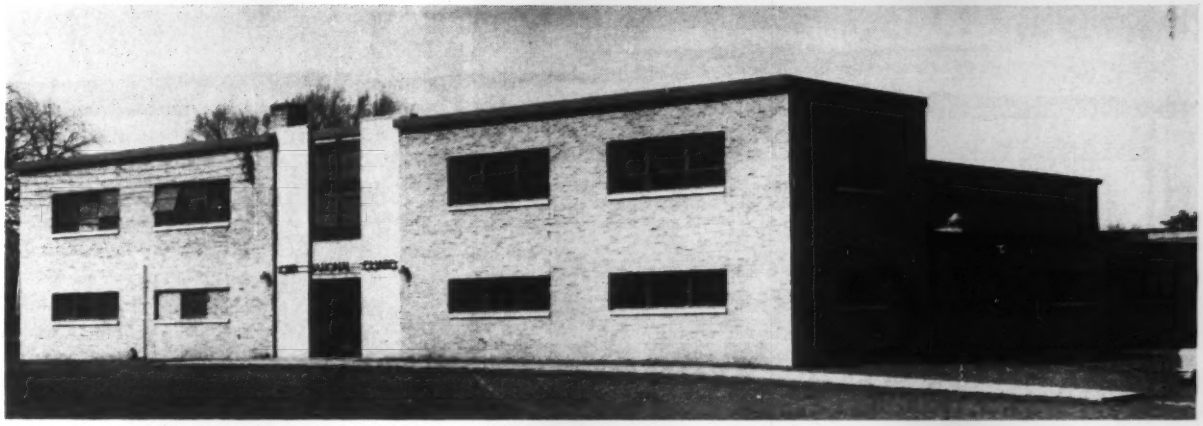
For more information write Industrial Combustion, Inc., 4507 N. Oakland Ave., Milwaukee 11, Wis., Dept. HPA-50.

INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICE: 4507 N. OAKLAND AVE., MILWAUKEE 11, WISCONSIN

Campbell

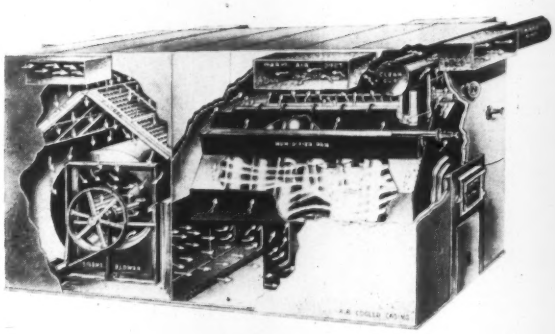
WARM AIR HEATERS FOR LARGE BUILDINGS



Iowa National Guard Armory Bldg., Chariton, Iowa, heated with a single No. 8125 Campbell combination gas-oil fired unit. Heating contractor, Meyers Sheet Metal Works, Waterloo, Iowa.

LOW IN COST — HIGH IN PERFORMANCE

Campbell Heaters provide all the natural advantages of warm air heat plus outstanding performance with low first cost and low operating costs. Campbell Heaters are noted for their quiet operation and fast heat delivery which are both so important in public buildings. Available for all fuels in capacities up to 3,150,000 BTUs. Let Campbell engineers help you on your next large heating job.

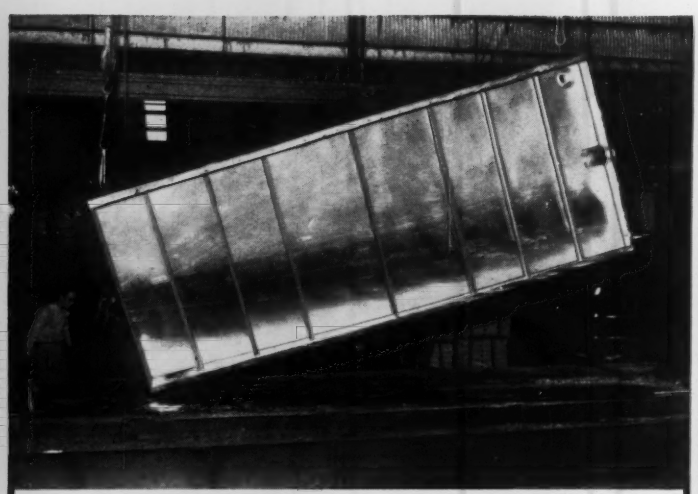


MANUFACTURERS' AGENTS

We have some very attractive openings for men calling on heating contractors and architects.

CAMPBELL HEATING COMPANY

Des Moines 17, Iowa



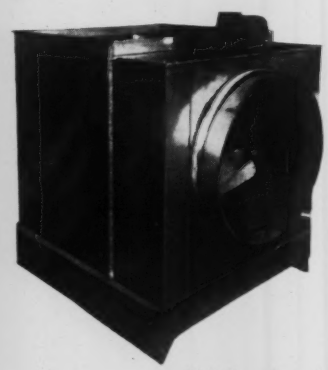
All Havens' tower casings, from the largest to the smallest models, are double-dipped after fabrication and before assembly. 100 Ton "V" series water basin is shown above after removal from the galvanizing kettle.

GALVANIZING THAT ADDS YEARS OF SERVICE LIFE TO

Havens Towers

Rigorous service and field tests adequately prove that heavy zinc coatings provide protection against rust for many, many years. Havens' specialized galvanizing process utilizes acid dipping, zinc ammonium chloride pre-flux and unhurried hot dip. The dip kettle is 50 inches wide, 60 inches deep and 25 feet in length. A quarter of a million pounds of molten zinc are maintained at 840° F. Material being galvanized is left in the dip until temperature is equalized. Over 2 ounces of molten zinc are applied to every square foot exposed, equal to a thickness of .0036 inches.

From pickling and pre-fluxing, through the galvanizing, Havens' Tower casings are adequately prepared to combat rust and corrosion.



FEATURES:

- Fan Screen
- Belt Guard
- Weather Protected Motors
- Stainless Steel Fan Shaft
- Sheaves, Corrosion Resistant Cast Iron
- Steel Sheets—Heavy Guage Hot Rolled Mild Steel

33 SERIES
3 to 120 TONS
"V" SERIES ALSO AVAILABLE
80 THROUGH 600 TONS

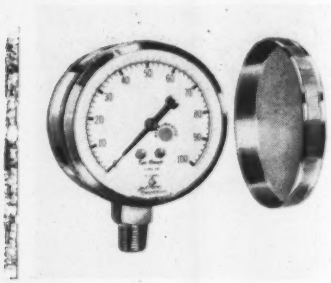
Write for Literature

PERFORMANCE PROVED

Havens COOLING TOWERS

Division of
HAVENS STRUCTURAL STEEL COMPANY
1713 CRYSTAL AVE., Kansas City 26, Missouri

EQUIPMENT DEVELOPMENTS
Continued

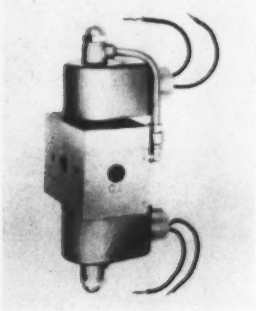


Test Gages . . .

. . . in 11 pressure ranges from 0 to 15 through 0 to 1000 psi plus 7 compound ranges; with 3 in. diameter dial, brass, nickel or chrome plated finishes and protective cover; feature brass cases with knurled access ring, calibration adjustment; accurate within ±0.5 percent of maximum dial reading, according to manufacturer—*Marsh Instrument Co., 3501 Howard St., Skokie, Ill.*

Blowpipe Elbows . . .

. . . in kit form, 12, 14, 16, and 18 gage hot-roll, black or galvanized steel, standard degree angles from 15 to 90, sizes 3 to 10 in.; supplied in 5 or 7 piece units, gores said to butt without gap for minimum welding time; elbows with throat radii from 2 in. up to 4 times pipe diameter also available.—*Wer-Coy Fabrication Co., 2332 Beniteau Ave., Detroit 11, Mich.*



Dual Solenoid Valves . . .

. . . for air, water, etc., handling on a-c or d-c voltages, in 10 to 250 psi pressure range; available with ¼ or ⅜ in. pipe connections, valves are 3-position—in center position all orifices are blocked; bulletin "8347" available on request — *Automatic Switch Co., Florham Park, N.J.*

The BURGESS-MANNING 3-WAY FUNCTIONAL CEILING

—*Here's* GREATEST DESIGN FLEXIBILITY

for SCHOOL HEATING . . .
COOLING . . .
ACOUSTICAL CONTROL

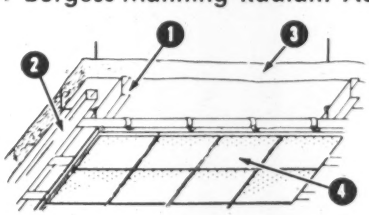
These are the
6 Points of Superiority

1. Maximum Comfort
2. Operating Economy
3. Maintenance Economy
4. Acoustical Efficiency
5. Attractive Appearance
6. Structural Simplicity

New 680 pupil Junior-Senior High School, Attica, N. Y. where Burgess-Manning Radiant Acoustical Ceiling insures a uniform temperature throughout the room, even close to windows.

Burgess-Manning perforated aluminum ceiling panels are clipped directly to coil for efficient heat transfer.

The Simple Construction of the Burgess-Manning Radiant Acoustical Ceiling



1. Suspension Grid
2. Hot or chilled water circulation coil.
3. Sound absorbing blanket.
4. Perforated aluminum ceiling panels clipped directly to coil for efficient heat transfer.

—as Proved at the Attica, N. Y. Junior-Senior High School

Concerned with school heating, cooling and acoustical control? Now . . . with the Burgess-Manning Radiant Acoustical Ceiling you combine *in one unit* all three functions to give pupil and teacher superior comfort.

The Attica, N. Y. school board members, interested in preservation of pupil health—after investigation of all types of school heating—selected the Burgess-Manning Radiant Acoustical Ceiling for their new Junior-Senior High School.

This highly effective Burgess-Manning Radiant Heating, Cooling and Acoustical Ceiling installation provides a very high standard of student and teacher comfort . . . attained at a moderate first cost, and definite economical operating costs—both well within the New York State averages for school buildings.

Simply . . . the Burgess-Manning Radiant Acoustical Ceiling provides:

1. completely uniform heat distribution with essentially no temperature variation from floor to ceiling;
2. elimination of radiators, baseboard convectors, registers, etc., permitting maximum usable floor space;
3. operation with standard hot water heating or water chilling equipment, and use of standard controls; and
4. design flexibility for layout, ventilation and lighting.

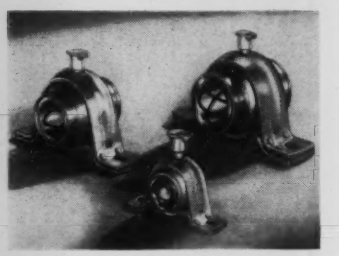
Easy to layout . . . easy to install . . . the Burgess-Manning Radiant Acoustical Ceiling gives you maximum freedom in architectural design, requires minimum building space, lower initial accommodation costs, and minimum mechanical maintenance.

Investigate the Burgess-Manning Radiant Acoustical Ceiling for school radiant heating, cooling and acoustical control! Complete descriptive literature, specifications and other pertinent design data sent on request. Today . . . write for Burgess-Manning Catalog No. 138-3

3 Heating Cooling Acoustical

BURGESS-MANNING COMPANY
Architectural Products Division
713 East Park Ave., Libertyville, Illinois

EQUIPMENT DEVELOPMENTS
Continued

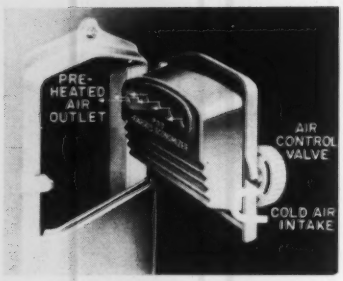


Pillow Blocks . . .

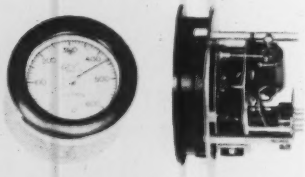
. . . in three series, with low silhouette, simplified two-bolt mounting arrangement, according to manufacturer; assembly is self-lubricated and self-aligning; said to be lighter in weight due to simplified housing design. Supplement "E" to catalog "57" available on request.—*Randall Graphite Bearings, Inc., Greenlawn Ave. and Lake St., Lima, O.*

Fuel Economizer . . .

. . . injects secondary air preheated up to 700 F over boiler fire for waste product combustion, smoke minimization; mounts on firebox door of high

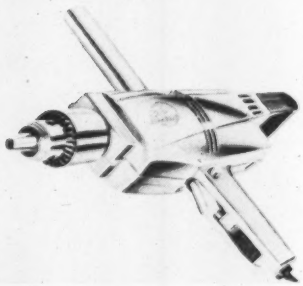


or low pressure units, requires no fuel or power; literature available on request—*Farris Combustion Controls Corp., 400 Commercial Ave., Palisades Park, N.J.*



Receiver-Indicator . . .

. . . for remote indication of pressure, flow, temperature, liquid level, etc., intended for use with manufacturer's line of electric transmitters, uses 115 v 60 cycle a-c with 50 w power consumption; in 4½, 6, and 8½ in. diameters; calibrated flow accuracy of ±1 percent of full range, ±2 percent full range for pressure and temperature measurement—*The Hays Corp., Michigan City, Ind.*

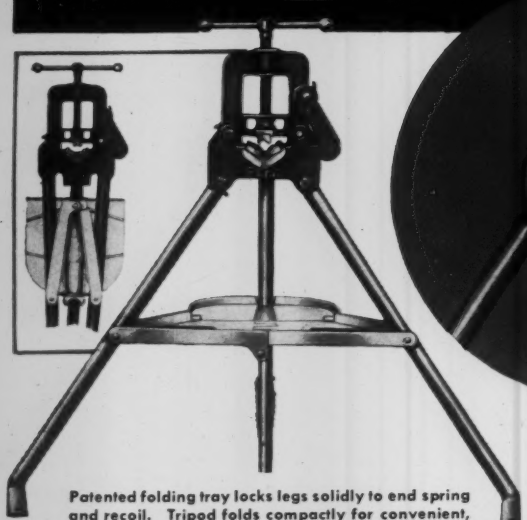


Electric Drills . . .

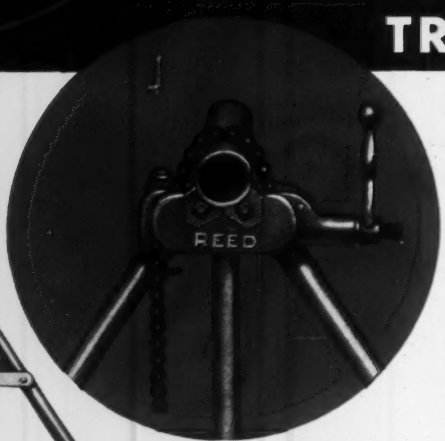
. . . of ¼, ⅜, and ½ in. capacity, plus ½ in. reversible with series-wound a-c/d-c motor, die-cast aluminum housing; models operate at 2400, 925, and 600 rpm no-load, with 3 to 6.5 amp ratings—*Thor Power Tool Co., Speedway Div., 1421 Barnsdale Rd., LaGrange Park, Ill.*

REED

PORTABLE *Folding Tray* TRIPOD VISES



Patented folding tray locks legs solidly to end spring and recoil. Tripod folds compactly for convenient, one-hand carrying. Sets up or takes down easily.



Improved Chain Vise features a convenient side handle which ends fumbling or skinned knuckles. Capacity from ⅛" to 4" makes it ideal for construction or maintenance work.

Now available with a new and better Chain Vise or the long-jaw Yoke Vise

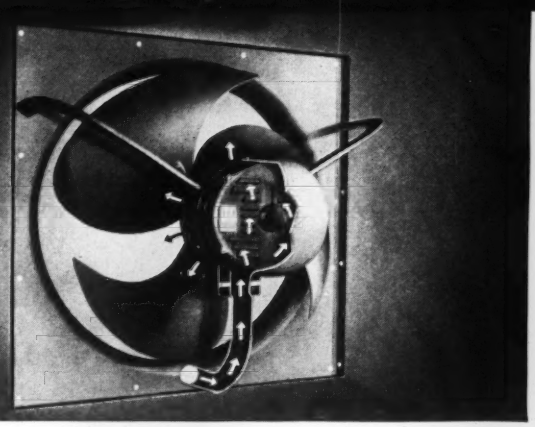
Reed Folding Tray Tripods are well known for their work-saving solidity and the ease with which they can be carried, set up or taken down.

The Chain Vise Model is easy and convenient to use because the handle is at the side where you can turn it easily and naturally. The chain drops into position even on 4" pipe. You never have to hold it with one hand while you tighten with the other. Hardened vise jaws have three faces for triple life.

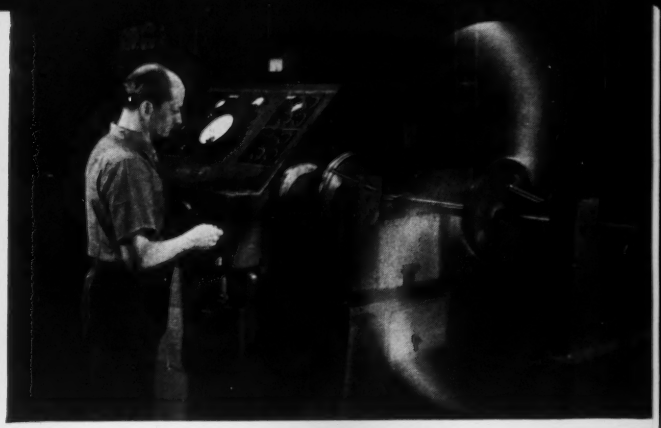
The Yoke Vise Model features the patented Reed long-bearing alloy steel jaws which provide a "wrench" action . . . so that a slight handle pressure holds any pipe from ⅛" to 2½". Reversible lower jaws. Special features to end lost motion.

Ask your jobber or write for free literature.

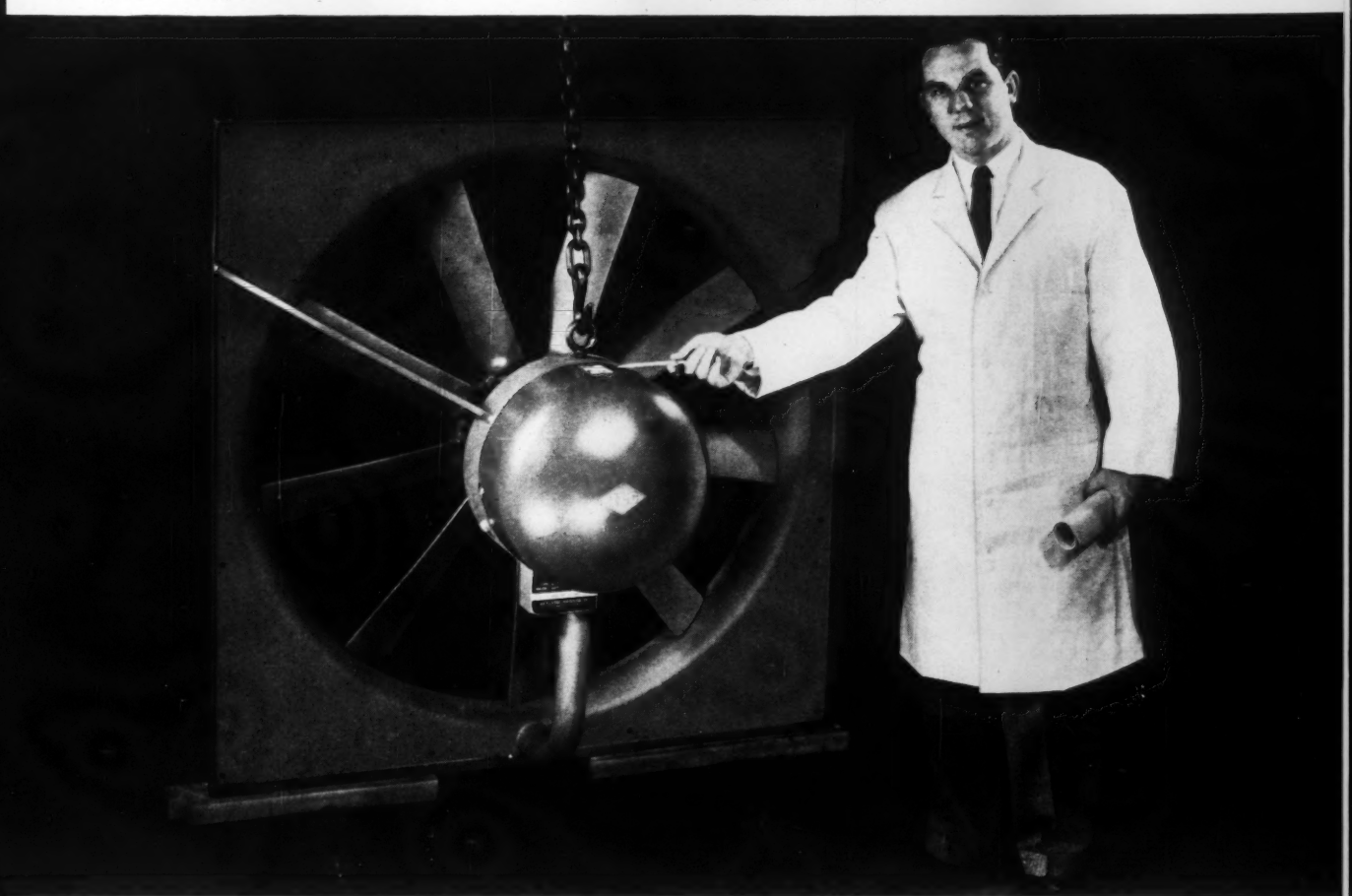
REED MANUFACTURING COMPANY
ERIE, PENNSYLVANIA, U.S.A.
TRADEMARK



Cool, Clean, Quiet. Vent pipe sucks in outside air, *pressure-cools* permanently lubricated Ilg-built motors—designed to provide operating cost advantages of *open-type* motors plus the protection of *totally enclosed* types.



"Check-Out" Time. Every Ilg-built propeller fan wheel must pass rigid dynamic balancing "checks" before being direct-connected to Ilg-built self-cooled, 3-phase or permanent split-capacitor, single-phase motor.



New ILG Square Panel Propeller Fans move up to 37,550 CFM

You're looking at the new Ilg Type PF square panel propeller fans. Note the sturdily constructed 14-gauge steel mounting panel; the deep-throated streamlined orifice that increases fan efficiency; the choice of fan wheels—airfoil design blades (either five or nine) for operating against higher static pressures, and Ilg's patented Type "Q" blades for super-quiet operation on ordinary requirements.

Choice of three sizes: 36-, 42- and 48-inch fan wheels. All fans feature Ilg self-cooled motors, direct-connected, permanently lubricated. And all bear the Ilg "One-Name-Plate" pledge of performance. Write for Bulletin DB1-106.

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Offices in 59 Principal Cities
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DO YOU KNOW WHY FAIRBANKS VALVES

ARE BEING SPECIFIED AND INSTALLED IN THE NATION'S NEWEST MOST MODERN BUILDINGS?

NATIONAL BISCUIT COMPANY BAKERY, FAIR LAWN, NEW JERSEY
OWNER, ARCHITECT AND MECHANICAL ENGINEER: National Biscuit Company, New York, N. Y. **GENERAL CONTRACTOR:** Walter Kidde Constructors, Inc., New York, N. Y. **PIPING CONTRACTOR:** The Frank A. McBride Company, Paterson, N. J.

- Because Fairbanks Valves are Quality—DEPENDABLE—products.
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- Because Fairbanks offers a full line of Bronze and Iron Body Valves for heating, piping and air conditioning systems.
- Because Fairbanks Valves are available the country over through stock carrying distributors in all the principal cities.

Do you have a copy of Fairbanks current Valve Catalog and Valve Comparison Chart? It will be a pleasure to send a copy of each to you.

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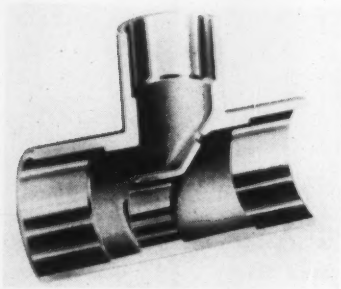
EQUIPMENT DEVELOPMENTS

Continued



Diversion Fittings . . .

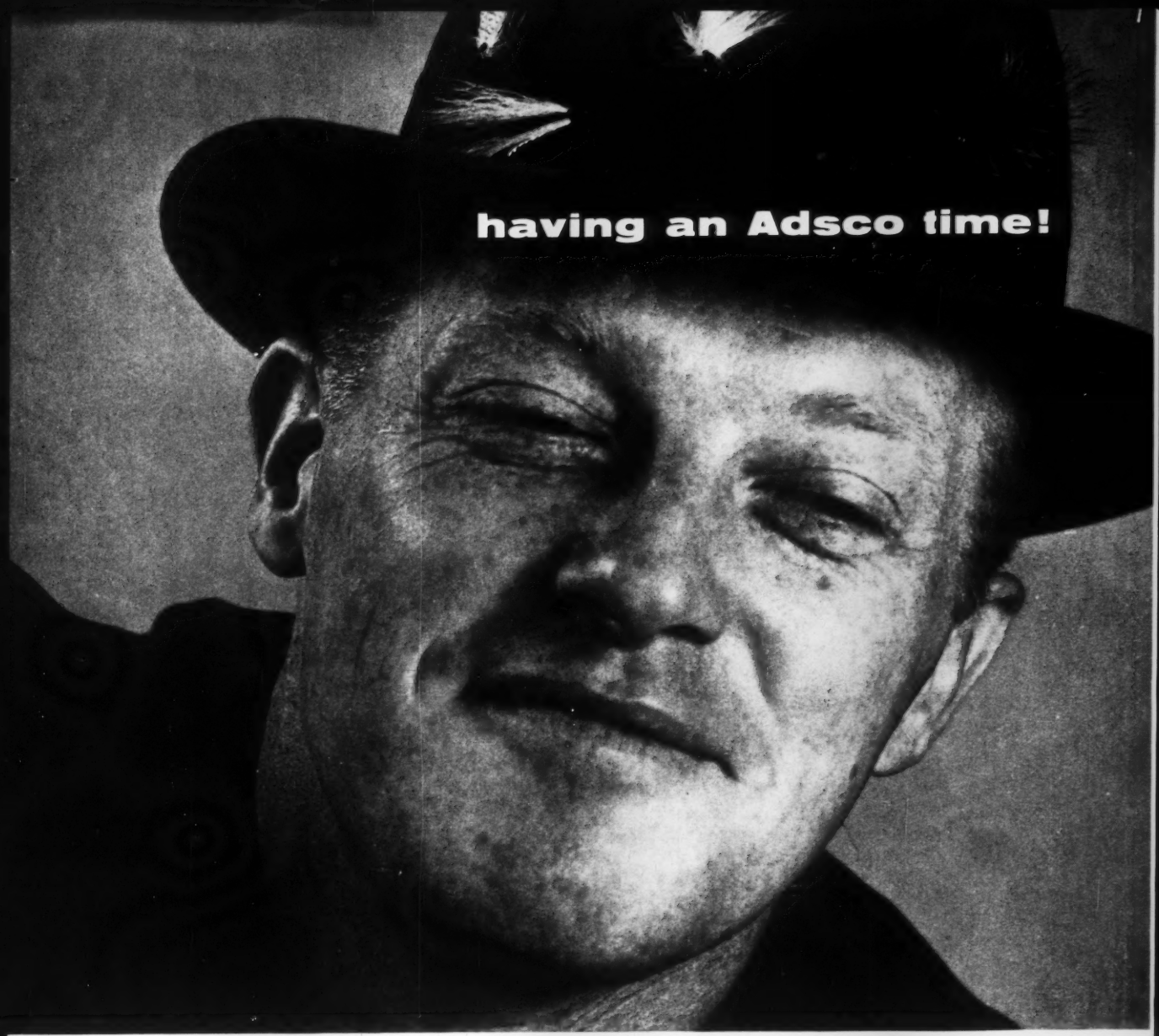
. . . in variety of sizes, for flow diversion to heating units in up-feed supply, up-feed return, down-feed supply or down-feed return systems; with cast-in nozzles, of cast bronze construction, with air-relieving hole between main and riser portions of fitting — *General Fittings Co., East Greenwich, R.I.*

Mechanized Cutter . . .

. . . designed primarily for oxyacetylene round hole cutting in pipe, tanks, and plates, makes straight, irregular or circular cuts; magnetic radius rod allows center fulcrum to rise and fall, producing round opening even on contoured surfaces, according to manufacturer; powered by 110 v variable speed motor—*Steffan Mfg. Corp., P.O. Box 275, Salem, O.*

Vacuum Gages . . .

. . . with 0 to 1000 microns or 0 to 20 mm of mercury ranges for continuous measurement of gas pressure under vacuum; portable or panel mounted, feature sealed meter, spring loaded on-off switch, battery powered operation; with $\frac{1}{8}$ in. male pipe thread fitting, matched gage tubes for multiple-location reading — *Hastings-Raydist, Inc., Hampton, Va.*



ONLY ADSCO HAS ALL 3 TYPES OF EXPANSION JOINTS

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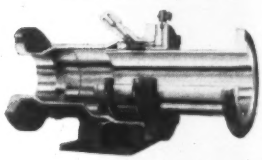
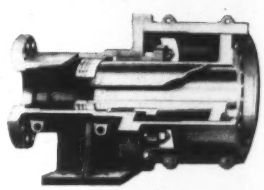


RAM-PAK



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YUBA — A growth corporation serving growth industries

chemical
petroleum
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heating
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RECENT TRADE LITERATURE . . .

▸ *AIR CONDITIONERS* — 2 specification folders available on air cooled packaged units with remote condensers (forms "LL-432" and "LL-433") plus form "LL-325" on hermetic liquid chillers. *Chrysler Corp., Airtemp Div., Dayton 1, O.*

▸ *ALUMINUM ALLOYS* — guide to selection gives firm's available sheet, plate, rod, bar, extrusion, and casting alloys and describes tempers, finishes and patterns; physical properties and available specialty products discussed. *Olin Mathieson Chemical Corp., Metals Div., 400 Park Ave., New York 22, N.Y.*

▸ *ALUMINUM BEARINGS* — sleeve bearings and bushings discussed in booklet "Alcoa Bearings" which lists sizes available, gives case histories, engineering and test data; illustrated. *Aluminum Co. of America, Alcoa Bldg., Room 732, Pittsburgh 19, Pa.*

▸ *ALUMINUM WELDING* — manual provides information on gas shielded arc welding with consumable and tungsten electrodes, brazing, cleaning and finishing, soldering with or without flux; includes aluminum alloy charts plus list of available joining products and fluxes. *All-State Welding Alloys Co., Inc., 219-55 Ferris Ave., White Plains, N.Y.*

▸ *ARC WELDERS* — for use where both a-c and d-c welding currents are required described in bulletins "NH-176" and "NH-177;" with lists of optional equipment plus description of stacking method. *National Cylinder Gas Div., Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.*

▸ *ARMORED PIPE* — plastic, with glass fiber reinforced outer covering described in bulletin "FRP-1" with impact and corrosion resistance characteristics, description of joining methods, corrosion and pressure tables. *Haveg Industries Inc., Plastics Park, Wilmington 8, Del.*

▸ *BLOWER ASSEMBLIES* — booklet outlines blowers and wheels, pulleys, brackets, bearings, pillow blocks available and describes various types of large diameter wheels being manufactured; with cross reference to firm's engineering catalog; booklet "LAD-866-759." *The Lau Blower Co., Blower Div., 2027 Home Ave., Dayton 7, O.*

▸ *BOILER SHUT-DOWN* — precautions for prevention of excessive scale when taking boiler off the line available in new instruction sheet. *Betz Laboratories Inc., Gillingham & Worth Sts., Philadelphia 24, Pa.*

STAINLESS

pipe and fittings

. . . in stock

Your complete stainless piping package is available for immediate shipment in a variety of sizes and analyses. **Pipe:** 1/8 ips through 12" ips seamless and welded, schedules 5-80. **Fittings:** 1/8 ips through 4" ips, threaded and welding type. **Valves:** 1/4 ips—2" ips. Also **mill shipments** of corrosion resistant items up to 48" OD. Send for FREE literature.

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NEW SIOUX air slugger

DOES 101 JOBS IN HALF THE TIME!

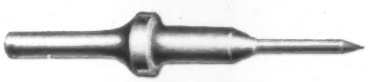
METAL WORKERS KIT NO. 270C

METAL CUTTER—
CUTS METAL SMOOTH & FAST!
—moves accurately and cleanly through sheet metal with excellent maneuverability and on any cutting radius.

CHISEL—**SHEARS BOLTS, SPLITS NUTS,** pulls pins, breaks spot welds.

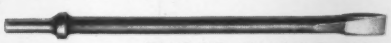
RIVET BUSTER—**SHEARS ALL TYPES OF RIVETS**

PUNCH—**PUNCHES OUT PINS, BOLTS,** studs, rivets, bearing races, and pressed bearings.



SHEET METAL PUNCH—**PUNCHES PERFECT HOLES FOR METAL SCREWS**—A precision made sheet metal punch that will punch perfect holes for metal screws faster than you can put them in place.

SCRAPER—**SCRAPES AWAY RUBBER COATING,** insulation or almost anything without damage to metal.



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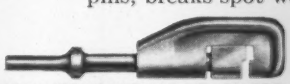
GETS AT THOSE "HARD TO REACH" PLACES and shears bolts, rivets, pins, breaks spot welds.

SPOT WELD BREAKER

BREAKS SPOT WELDS QUICKLY, easily, inexpensively. A hardened tool that will take long, hard, punishing use.



CRIMPER—
MAKES A STRONG NEAT, SHEET METAL JOINT, means faster, neater, better work, and more profit.

The SIOUX Air Slugger is one of the most useful of air tools. It will not create the hazard of fire or explosion and will save cost of torches and gas. Design features include a one piece barrel with no parts to get misaligned or wear out; and a cast iron handle that will survive the roughest treatment. It's light, sturdy, and SIOUX dependable.

Look for **SIOUX** *Tools in the yellow pages under "TOOLS, ELECTRIC"*

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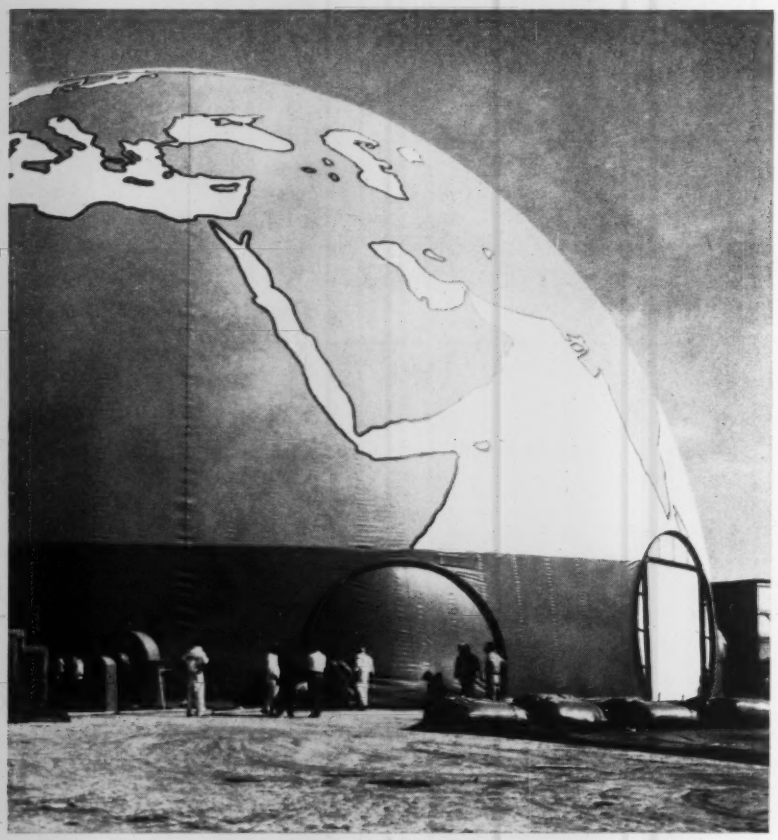
AIR IMPACT WRENCHES • AIR SCREWDRIVERS • ELECTRIC IMPACT WRENCHES • DRILLS • SCREWDRIVERS • GRINDERS • SANDERS • POLISHERS • FLEXIBLE SHAFTS • PORTABLE SAWS • VALVE GRINDING MACHINES • ABRASIVE DISCS.

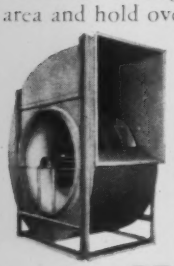
ANOTHER PEERLESS ELECTRIC SPECIAL BLOWER APPLICATION



How to Stabilize Air-Supported Structures

EVEN IN 70 MPH WINDS, PEERLESS ELECTRIC BLOWERS FIRMLY SUPPORT THESE HUGE ARMY PENTADOMES

Twelve Peerless Electric Centrifugal Blowers, each with a discharge of 22,000 cfm, are responsible for the inflation and support of the Army's hemispheric "Pentadome." Designed for use as missile maintenance centers, the structures tower as high as a nine-story building, cover 17,000 square feet of floor area and hold over a million cubic feet of volume.



Peerless Electric has pioneered the application of inflating and maintaining a variety of air-supported structures, including Radomes. The same skills that engineer air for Pentadomes can go to work for you. Write to *Peerless Electric Division, H. K. Porter Company, Inc., West Market Street, Warren, Ohio.*

PEERLESS ELECTRIC DIVISION

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H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

RECENT TRADE LITERATURE

Continued

▶ *BRASS FITTINGS* — catalog "60" describes company's facilities, packaging and shipping methods, with list and technical data on line of fittings and valves; pictorial cross sections and dimensional data included. *Lee Brothers Foundry Co., Inc., Box 231, Anniston, Ala.*

▶ *BUTTERFLY VALVES* — bulletin "590X" outlines advantages claimed over other types of valves for similar requirements, with body, bearing, and closure feature described and illustrated; construction materials for different parts also listed. *W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn.*

▶ *CARBON AND ALLOY STEELS* — chart shows approximate relation between tensile strength and "hardness" determined by Brinell, Monotron, Vickers, and Rockwell testing systems; technical data card "183." *The Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.*

▶ *CLASSROOM AIR CONDITIONING* — application manual (form CC-601-M3) describes system of heating, ventilating, air conditioning school rooms by means of perimeter distribution system; with illustrations of typical installations, adaptation for various fuels, duct design and control data. *Lennox Industries Inc., 200 S. 12th Ave., Marshalltown, Ia.*

▶ *COIL SELECTION* — tables are provided for manufacturer's air conditioning unit line; lists cooling performance for each unit at 5 cfm capacities, 3 chilled water conditions for each cfm level; direct expansion and water or steam heating units also covered. *Recold Corp., 7250 E. Slauson Ave., Los Angeles 22, Calif.*

FLEXIBLE AND VERSATILE
RUGGED AND RELIABLE

McQuay offers you more flexibility and versatility with the "HC" heating and ventilating units.

Rugged "V" channel frame construction with continuous galvanized steel panels, bonderized and oven baked enamel coated, gives you the finest quality available anywhere.

McQuay "HC" heating and ventilating units may be selected in either horizontal or vertical types in 19 sizes ranging in capacity from 1280 cfm to 48,330 cfm. Eight capacity ranges are available with standard steam, jet tube steam or hot water coils. You can choose from eight fan discharge arrangements and 18 accessories arrangements designed to fit your individual needs.

For the greatest reliability, for the greatest possible flexibility and versatility, buy McQuay. There is a McQuay representative in or near your city, or write McQuay, Inc., 1601 Broadway Street N. E., Minneapolis 13, Minnesota.

McQuay "HC" horizontal heating and ventilating unit. Available in three types of coils; standard steam, jet tube steam and hot water.

McQuay "HC" vertical heating and ventilating unit. Also available in three types of coils. A full line of accessories is available for all models.

M Means Quality

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

Revolutionary Tool!

New Tee Turner cold draws reducing tees –no fittings necessary!

Here's the most revolutionary development in copper plumbing in a decade—a portable tool that "turns" reducing tee connections in K, L, M and DWV copper tubing (1¼" to 4") in five minutes.

The Tee Turner works equally well in the shop or on the job. It saves literally hundreds, even thousands of dollars on big jobs by (1) eliminating the need for reducing tee fittings, and (2) reducing the number of solder joints at each branch from 3 to 1. Cuts labor costs on tubing installations up to 75%!

The Tee Turner has been approved and specified for branching by consulting engineering firms all over the U.S. It has been used in the construction of schools, hospitals, motels, industrial plants, commercial buildings, and residences. In addition, it has proven ideal for remodeling and maintenance work in large plants and commercial buildings.

This tool is already being used by plumbers and mechanical contractors in Boston, Metropolitan New York, Newark, Miami, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, St. Louis, Dallas, Denver and Los Angeles.

Tee Turner tools are available for both water distribution and drainage systems. For complete information fast, write, wire, or mail coupon to *The Erie Tool Works, Dept. C-5, Erie, Pennsylvania.*

INFORMATION ON THIS REVOLUTIONARY TOOL!

THE ERIE TOOL WORKS, ERIE, PA., U.S.A.

Rush me literature with all the facts on the Tee Turner.

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C-5,

RECENT TRADE LITERATURE

Continued

▶ *COMBUSTION CONTROL* — bulletin "C11" describes 9 custom engineered central control systems for steam boiler systems employing standard panels, cubicles, specified components. *Webster Engineering, Div. of Midland-Ross Corp., P.O. Box 5246, Tulsa, Okla.*

▶ *CONTROLLED SPEED SYSTEMS* — for a-c motor applications described and illustrated with schematics, application drawings; includes advantages claimed by manufacturer for fixed-speed motor conversion by use of system employing simple circuitry. *U.S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.*

▶ *CONVECTORS* — catalog "4059" describes 13 models for large building commercial-institutional application; with construction details, steam ratings, dimensional data, heating effects, hot water conversion factors, pressure and temperature drop data and typical piping connections. *Young Radiator Co., 709 S. Marquette St., Racine, Wis.*

▶ *COOLING COILS* — catalog "406" provides direct selection method for all types plus data compilation for specification matching; firm's line of coils are described with circuiting illustrations and application recommendations; with psychrometric charts. *McQuay, Inc., 1600 Broadway St., N.E., Minneapolis 13, Minn.*

▶ *COOLING TOWERS* — bulletin "207" describes line of 10 to 700 ton factory assembled units, with capacity and performance data, selection tables, engineering drawings for blow-through, draw-through, centrifugal and axial fan models. *Baltimore Aircoil Co., Inc., P.O. Box 7322, Baltimore 27, Md.*

▶ *CORROSION RESISTANCE* — rating guide gives relative ability of various metals, plastics, synthetics used in line of ball-type valves to resist corrosive effects of 390 industrial fluids; aluminum, carbon steel, stainless steel, various plastics and synthetic rubbers included. *Hydromatics, Inc., 70 Okner Pkwy., Livingston, N.J.*

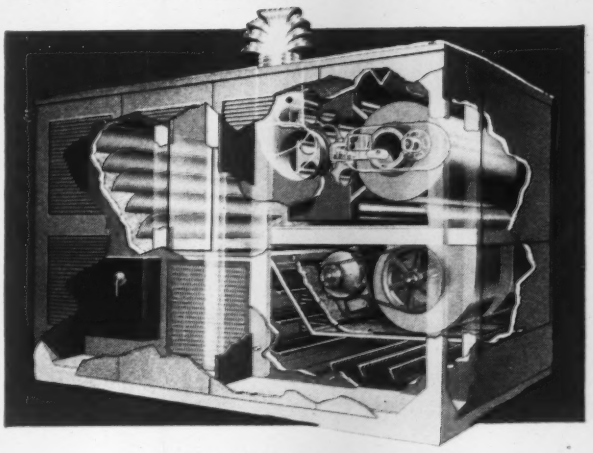
▶ *DIFFERENTIAL PRESSURE INDICATOR* — for remote air and gas indication, control, recording, alarm, and interlock with 10 ranges 0.01 to 100 in. water gage described in data sheet "172". *Hastings-Raydist, Inc., Hampton, Va.*

▶ *DUCT FANS* — axial flow, direct and belt driven types for non-corrosive or corrosive air handling, designed to bolt into system as duct section, detailed in bulletin "AF-1". *Bowman Steel Corp., P.O. Box 2129, Pittsburgh 30, Pa.*

MAMMOTH

Compact-Aire

ROOF-TOP HEATING AND COOLING



Oil or gas 185,000 to 500,000 B.T.U. output.
Cooling capacity available: 3 to 20 tons.

For Shopping Centers, Supermarkets, Drive-ins, Commercial Buildings, Offices, Schools and Churches

Everything Goes On The Roof! Saves hundreds of square feet of expensive floor space. Roof space costs nothing. Saves by eliminating complex duct work, piping, and wiring. Simplified and lowered constructions and installation costs produce total savings that could pay for entire system.

Year Round Fresh Air Comfort. Fresh air is picked up at roof-top level, filtered, heated or cooled according to season. High efficiency of Compact-Aire assures 12 month comfort air-conditioning.

For Big Buildings and Small. Extreme simplicity of installation, flexibility of units and low cost of operation makes Compact-Aire Roof-Top Heating & Cooling ideal for buildings of all sizes. Write for information.

MAMMOTH FURNACE COMPANY
6425 Gambridge St., Minneapolis, Minnesota
Gentlemen:
Please send information on Compact-Aire Roof-Top Units, available sizes, costs, etc.

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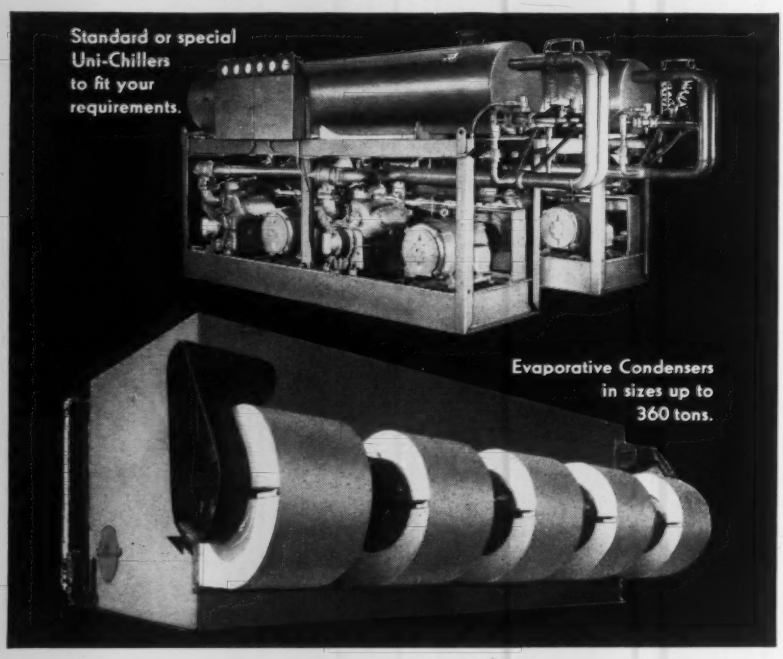
ADDRESS _____

CITY _____ STATE _____

Increased performance and continued lower costs with Vilter Air Conditioning



Vilter units for many air conditioning applications are designed to make every dollar count in increased performance, more economical operation, longer life, a more compact installation, and a minimum of maintenance. Years and years of research went into the design of the famous VMC Compressor and Equipment, and this research is continuing at an intensified pace—all aimed at making the VMC Compressor the most durable and efficient on the market.

Uni-Chillers—Each of the special Vilter self-contained units (shown above) consists of two compressors and 75 hp motors, condenser, water chiller and controls. The capacity of each Uni-Chiller is 150 tons. Completely factory-assembled. Compact Uni-Chillers are available in sizes from 10 tons upward.

Evaporative Condenser—The externally mounted fan of the VXF evaporative condenser (shown above) does not handle moist saturated air from the spray chamber—minimizes corrosion and extends fan life. The Evaporative Condenser saves 90 to 95% in water costs. Permits larger compressor installations where water is scarce. Low pumping cost as compared to cooling tower installation. Capacities of 30 through 360 tons.

Why not write to Vilter and see how you, too, can save money on your air conditioning and refrigeration installations.

Vilter® refrigeration air conditioning

The Vilter Manufacturing Company
Milwaukee 7, Wisconsin
Air Units • Ammonia and Freon Compressors • Booster Compressors Baudelot Coolers • Water and Brine Coolers • Blast Freezers Evaporative and Shell and Tube Condensers • Pipe Coils Valves and Fittings • Pakice and Polarflake Ice machines.

Write to Dept. F-906 for helpful Vilter Bulletins on any of the above equipment.

RECENT TRADE LITERATURE
Continued

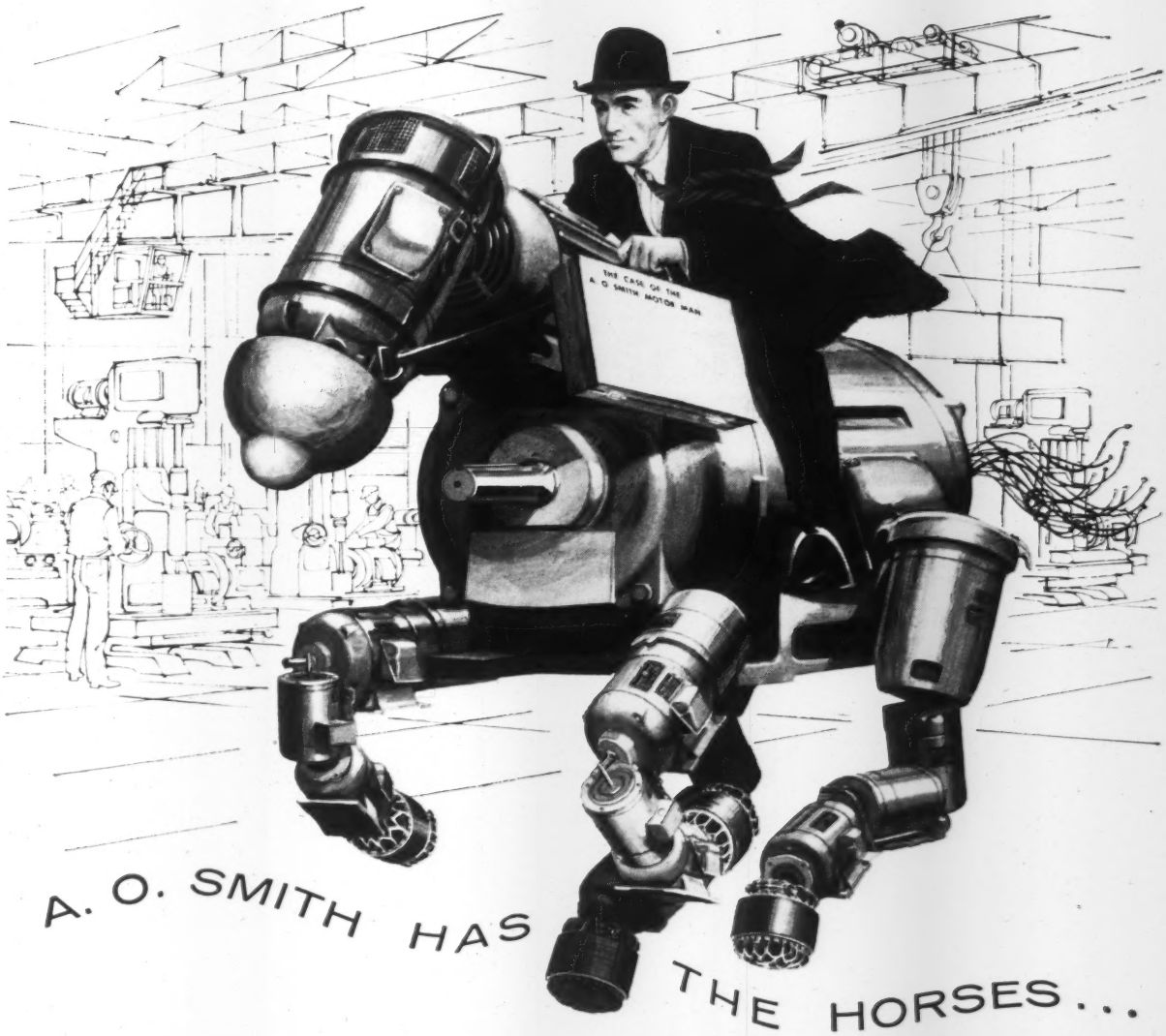
▶ *ELECTRICAL EQUIPMENT* — for low-voltage distribution requirements, including safety switches, tumbler and open-knife switches, circuit breakers, motor control centers, and others described in catalog "GEC-1100B", with selector, charts, pricing tables, ratings, weights, dimensions and ordering information. *General Electric Co., Distribution Unit, Plainville, Conn.*

▶ *ELECTRIC MOTORS* — fractional and sub-fractional hp, unreduced and gear reduced, shaded pole, d-c, and universal types for variety of applications described in new brochure. *SpeedWay Div., Thor Power Tool Co., 1421 Barnsdale Rd., LaGrange Park, Ill.*

▶ *ELECTRIC MOTORS* — enclosed polyphase squirrel-cage type, 1 hp and larger with NEMA C-type faceplates for centrifugal pump applications covered in bulletin "MC-244" with cut-away illustration detailing advantages for close-coupled pump attachment. *Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 33, Mo.*

▶ *ELECTRIC MOTORS* — brochure describes manufacturing, distribution, and service facilities said to provide exceptional advantages for customers; bulletin "F-1974". *U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.*

▶ *ELECTRODES* — for a-c and d-c welding detailed in 7 data sheets including those for mild steel, medium carbon steel, high carbon steel applications. *National Cylinder Gas Div., Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.*



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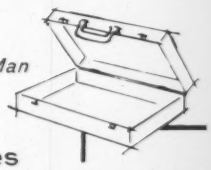
deliver the goods-start to finish!

Yours from the case of the A. O. Smith Motor Man



...the complete story of these 800 to 1 hp favorites and their winning ways in the toughest going

Don't spare the horses! Whatever the load, whatever the distance, the horses of A. O. Smith go to the post with that something extra that pays off in the stretch. Single-phase models (1-5 hp) or poly-phase (1-800 hp), you'll find these motors equal to every challenge encountered on the most rugged applications.

And you can always rely upon your nearby A. O. Smith Motor Man. He'll ride all night to provide you with 24-48-hour action on all parts and service orders.

Through research ...*a better way*

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Tipp City, Ohio

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Milwaukee 1, Wisconsin, U. S. A.

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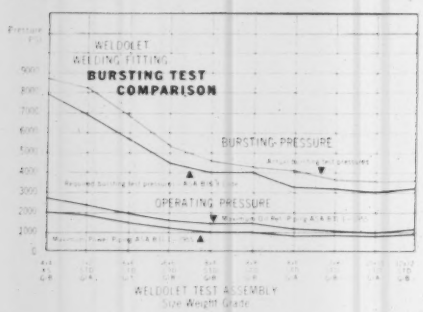
new redesigned
BONNEY WELDOLETS
for reinforced branch connections on carbon steel and alloy pipe

Welding fittings manufactured and tested in accordance with ASA B16.9 and ASA B31.1

clean-cut bevel with exactly 1/16" land
bore machined with a watchmaker's precision and finish
reduced angle of bevel ... weld volume cut almost 50%
weld line clearly defined ... no more errors about "how much to weld"
skirt taper redesigned for improved stress distribution

RESULTS? OVER 4½ TIMES MAXIMUM OPERATING PRESSURE



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CARBON STEEL
STAINLESS
ALLOY
for all services

For high strength and low-total installed cost compare with . . . other reinforced branch construction . . . unreinforced branch construction . . . and welding tee construction. Then specify and use Weldolet fittings for all full size and reducing branch connections.

BONNEY FORGE AND TOOL WORKS

ALLENTOWN, PENNSYLVANIA

RECENT TRADE LITERATURE
Continued

▸ *ELECTRONIC AIR-CLEANER* — consisting of static generator, bank of 3 galvanized steel wire screens, operating on 75 w, 115 v, 60 cycle power described in new brochure which illustrates principle of "particulate bombardment" and negative ionization for reduction of particle size below 0.1 micron. *CRS Industries, Inc., 1405 Locust St., Philadelphia 2, Pa.*

▸ *EVAPORATIVE CONDENSERS* — in 10 to 700 ton sizes, factory assembled units described in bulletin "107" with engineering drawings, capacity and performance data, selection tables and description of blow-through, draw-through, centrifugal and axial fan models. *Baltimore Aircoil Co., Inc., P.O. Box 7322, Baltimore 22, Md.*

▸ *FLEXIBLE METAL CONNECTORS* — for pipeline expansion compensation, noise and vibration damping, misalignment correction, of bronze, stainless steel and carbon steel described and illustrated in catalogs "539" and "659" with price lists for bronze units, dimensional and operating data tables. *Cobra Metal Hose, 5059 S. Kedzie Ave., Chicago 32, Ill.*

▸ *FLEXIBLE DUCT* — for air conditioning, industrial ventilation, and materials handling covered in new brochure; includes selection guide to 6 types of duct available, with specifications and suggested applications. *The Wiremold Co., Hartford 10, Conn.*

▸ *FLOW CONTROL VALVES* — in 6 pipe sizes, for 0.2 to 50 gpm requirements detailed in brochure with dimensional and operating specifications. *Automatic Controls Div., Hays Mfg. Co., 803 W. 12th St., Erie, Pa.*

Keflex Manufacturing Division
U. S. Flexible Metallic Tubing Co.
Since 1905

KEFLEX
LAMINATED
STAINLESS STEEL BELLOWS

General Offices — 63 Main St., San Francisco 5, Calif.
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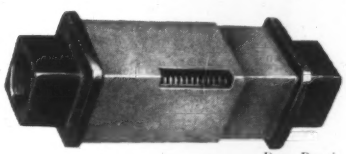
KEFLEX QUADRA-SIDE EXPANSION COMPENSATORS

FOR STEAM AND HOT WATER HEATING SYSTEMS USED WITH CONVECTOR AND FIN TUBE BASEBOARD RADIATION UNITS IN SCHOOLS, HOSPITALS, OFFICES AND COMMERCIAL INSTALLATIONS

TYPE 7 Q square brass telescoping case protects laminated stainless steel bellows from torsion, squirm, misalignment and external damage. Compensators are used in high and low pressure hot water supply lines, risers and for baseboard radiation. Extra flexibility provides maximum cyclic life. Units are very compact and rugged. Sizes ¾" thru 3". Pressures to 300 PSI. Temperatures to 800 F. Traverse: Single Units, total 2" (1-½" compression, ½" extension) Dual units available.

TYPE 11 Q-T has heavy square telescoping case and laminated stainless steel bellows. For use in risers and with baseboard radiation. Test pressure 150 PSI, working pressure 100 PSI, temperatures to 300 F. Traverse: Total 1" (¾" compression, ¼" extension).

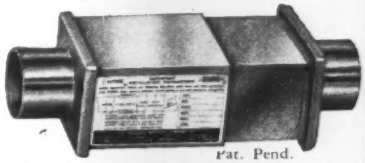
TYPE 7 Q WITH BRASS FEMALE THREADED ENDS
Working Pres. 300 PSI Maximum
Temp. 800 F



Pat. Pend.

Nom. I.P.S.	Overall Length	Max. O.D.	Wt. #
¾"-1.00"-1.25"	6.50"	2.00"	2
1.50	6.50	2.50	4
2.00	6.50	3.00	5
2.50	6.50	3.50	6
3.00	6.50	4.00	9

TYPE 7 Q-T WITH COPPER TUBE ENDS
Maximum Pres. 200 PSI Maximum
Temp. 300 F



Pat. Pend.

To Fit Copper Tubing		Overall Length	Max. O.D.	Wt. #
Nominal I.D.	Actual O.D.			
¼"	⅞"	6.50"	2.00"	1½
1	1⅛	6.50	2.00	1½
1¼	1⅜	6.50	2.00	1½
1½	1⅝	9.00	2.50	3½
2	2⅛	10.00	3.00	4½
2½	2⅝	10.75	3.50	5½
3	3⅛	11.50	4.00	8¼

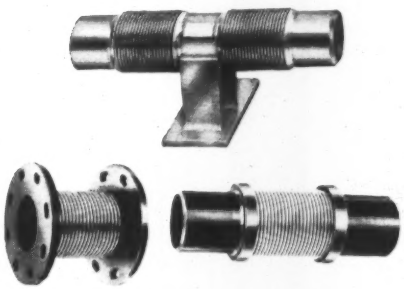
TYPE 11 Q-T WITH COPPER TUBE ENDS
Maximum Pres. 100 PSI Maximum
Temp. 300 F

Pat. Pend.

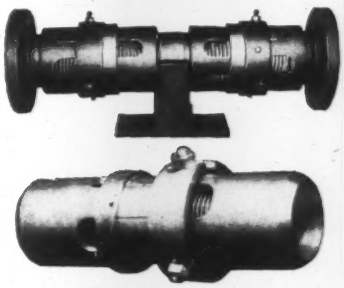
To Fit Copper Tubing		Overall Length	Max. O.D.	Wt. #
Normal I.D.	Actual O.D.			
¾"	⅞"	4.50"	1.50"	1¼
1	1⅛	4.50	1.50	1¼
1¼	1⅜	4.50	1.75	1½
1½	1⅝	4.50	2.25	3
2	2⅛	4.50	2.75	4

EXPANSION JOINTS—VIBRATION ABSORBERS—FLEXIBLE CONNECTORS—PIPE GUIDES

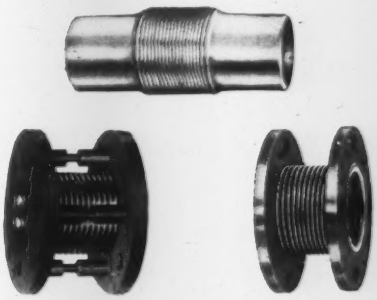
Force Required to Compress Keflex Expansion Joints Their Full Rated Traverse is Usually Less Than 100 Lbs., Total



KEFLEX EXPANSION JOINTS — corrugated, packless type for steam and hot water heating systems and process piping. Laminated stainless steel bellows with internal liner guides and stainless steel contour control rings. Weld ends, or flanges. Outside shrouds and intermediate anchor bases available. Sizes 2" through 48". Pressures 70 to 450 PSI. Temperatures to 800° F. Furnished for various required traverses.

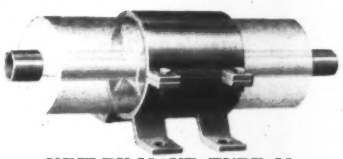


KEFLEX-KETROL CONTROLLED EXPANSION JOINTS — positive protection against torsion. For use in pipe lines to compensate for expansion and contraction. Shroud has intermeshing fingers providing concentric guiding and protection against squirm, torsion, and external damage to laminated stainless steel bellows. Designed for high pressure, high temperature hot water service. Movement is controlled by limit stops. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.



KEFLEX FLEXIBLE CONNECTORS AND VIBRATION ABSORBERS — to absorb vibration from pumps, chillers, and compressors. Serves to relieve stress on pump volute when piping is misaligned. Extra flexibility of laminated stainless steel construction produces long cyclic life. Compact units save space and are easy to install. Available with or without tie rods. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.

Modified Types are available for special conditions requiring higher pressure, temperatures, traverse, or combination deflections.



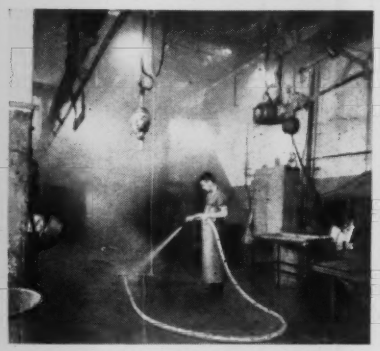
KEFLEX-MAVE TYPE M
Fabricated steel pipe guides for concentric guiding of pipe lines. Special insulated guides are available for chilled water.

FLEXIBLE "BMH" CONNECTORS

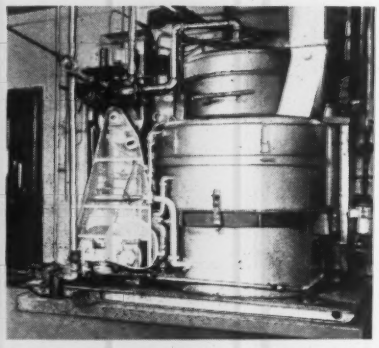
"USF" BRONZE VIBRATION ABSORBERS

Braided bronze Metal Hose assemblies made in standard lengths. Usually used as flexible connectors on pumps and other mechanical equipment for heating and air conditioning service. Available with threaded male ends, flanges, and copper tube sweat ends.

3 BOILERS IN 1 COMPACT PACKAGE!



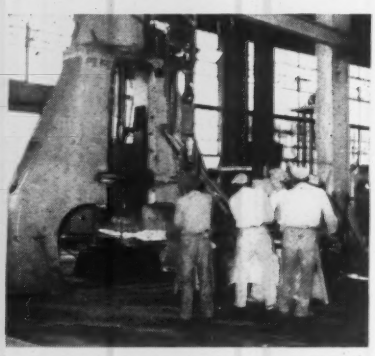
FOR ORDINARY STEAM REQUIREMENTS: The cycle-type Modulātic standard unit furnishes 90% dry steam for most ordinary needs such as cooking, heating water, drying, cleaning, etc.



WHERE DRY STEAM IS REQUIRED: The Modulātic may be used with an optional steam separator, for over 99% dry steam for heating, moulding, forges, operation of power equipment, etc.

VAPOR MODULĀTIC WATER TUBE BOILERS

¼ the size and weight of conventional boilers... largest size (150 BHP) uses only 5′ x 8′ space.



IF CONSTANT STEAM LOAD MUST BE MAINTAINED: For applications where even a nominal drop in pressure cannot be allowed, an optional steam reservoir may be added to the standard unit to provide a "cushion" during an off cycle.

Efficient . . . economical . . . proved in thousands of installations all over the world! Vapor Modulatics furnish high or low-pressure steam (at design pressures up to 1000 psi, or even higher). Lowest installation costs—delivered completely assembled, wired and tested . . . all sizes (40 to 150 BHP) fit through plant doors, with no special foundations or special chimneys needed. Simple push-button operation; built-in safety controls. May be mounted in multiple units to provide for the largest steam requirements—without the inefficiency of idling larger single boilers as demand slackens.

send for free literature:

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Please rush me your free bulletins on Modulātic Water Tube Boilers.

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SAFETY VALVE SETTING_____
MINIMUM STEAM LOAD_____
MAX. STEAM LOAD_____
STEAM PRESSURE_____
TYPE OF FUEL_____

RECENT TRADE LITERATURE

Continued

▶ *FLUID FILTER ELEMENTS* — of wire cloth described in brochure "142" with list of typical fluids and systems for which line of elements is applicable; with photographs and line drawings of construction details and manufacturing techniques. *Bendix Filter Div., Bendix Aviation Corp., 434 W. 12-mile Rd., Madison Heights, Mich.*

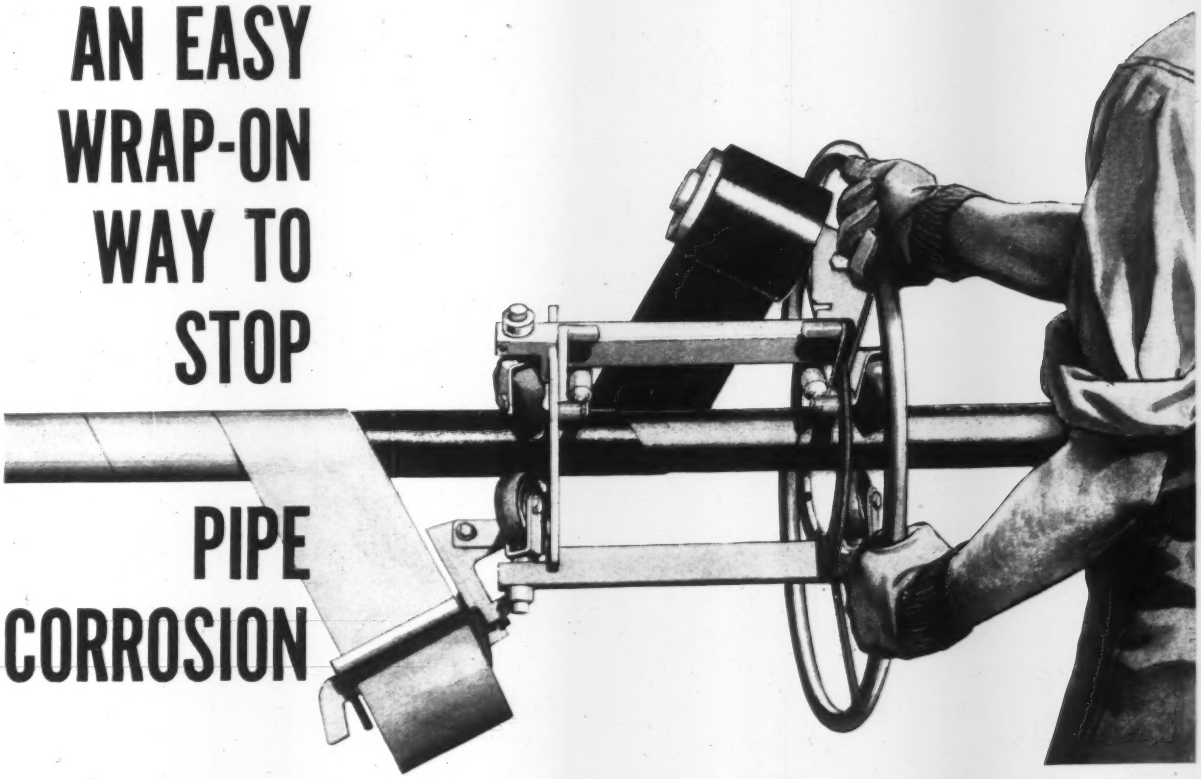
▶ *FLUID METERS* — bulletin "20" lists operational data, ranges, and installation requirements of firm's line of meters, plus discussion of available integrators, compensators, and primary elements. *Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, O.*

▶ *HEATING-AIR CONDITIONING PRODUCTS* — bulletin "B-5529" describes in brief complete line of air conditioning and air handling equipment, heat exchangers, surface condensers, steel boilers and related products and gives basic ratings for each. *American-Standard Industrial Div., Detroit 32, Mich.*

▶ *HERMETIC SEALS* — available for evacuated or pressurized enclosures detailed in catalog "1259" with illustrations and dimensional specifications, plus accepted glass seal nomenclature, general manufacturing techniques and usage recommendations. *Dage Electric Co., Inc., Beech Grove, Ind.*

▶ *HYDRONIC EQUIPMENT* — wall-hung and baseboard types for commercial, institutional, and industrial applications including high temperature hot water installations; with size and rating tables, roughing-in dimensions, tapping diagrams. *Shaw-Perkins Mfg. Co., 201 E. Carson St., Pittsburgh 19, Pa.*

AN EASY WRAP-ON WAY TO STOP PIPE CORROSION



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Pressure-Sensitive Polyethylene Tape has an extra-heavy adhesive mass that clings to clean pipe on contact . . . makes a perfect, permanent bond that rustproofs, waterproofs and insulates pipe against all types of corrosion.

Chasewrap*

Protective Overwrap is a tough, wrinkle-free outerwrap that shields against abrasion, wear, and physical damage to the tape. Wraps simultaneously with the tape. Superior to rag and felt wraps, yet far lower in cost.

*Trade name of Chase & Sons, Inc., long-famous for protective and insulating tapes for electrical wire and cable

The new CORR-PREV Pipe Coating Team comes in easy to handle tape form. It goes on pipe faster and lasts longer than corrosion-proof paints. It's cleaner and simpler to apply, too, than hot tar coats. And most important, this new CORR-PREV Team offers all the cost-cutting, pipe-saving advantages of *polyethylene* tape.

With CHASEWRAP Abrasion-Resistant Overwrap and Chasekote polyethylene tape, you get the easiest and best pipe protection at *lowest applied cost!* There's no heating, drying, clean-up or shut-down time. Each roll is factory-uniform in thickness and quality. And all coating materials — including rental of high-speed applicators — are available from one reliable source. Want samples? Specs? Prices? Write **CHASE & SONS, INC., Spruce St., North Quincy, Mass.**

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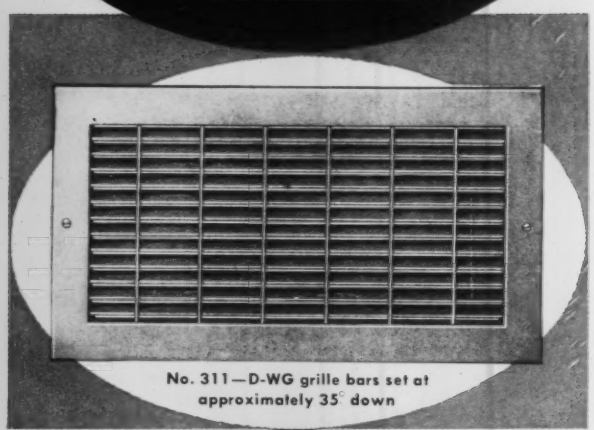
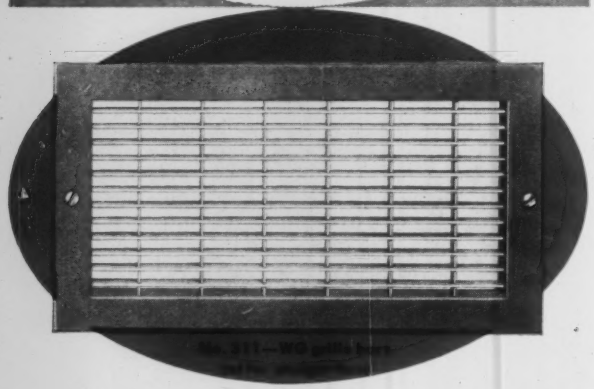
ALUMINUM WALL GRILLES
Independent "Fabrikated"
REG. U.S. PAT. OFFICE
These wall grilles are famous "Fabrikated" construction but made from solid bar aluminum instead of steel.



No. 311—D-WG grille bars set at approximately 35° down



In these grilles, the openings are ⅜" x 1 11/16". Interior grille bars are ½" deep. Outer rims up to vertical 12-inch sizes inclusive are 1 1/16" wide beyond wall openings on all four sides. On sizes over 12-inch vertical, outer rims are 1 5/32" wide on all four sides beyond wall opening size. Approximate depth of all grilles is ¼". Narrower or wider rims available on special order at moderate additional cost.

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Always Progressing

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RECENT TRADE LITERATURE

Continued

▸ *INDUSTRIAL ADHESIVES* — coatings, and other pressure-sensitive products described in manual which cross-indexes products by type, function, application and Armed Forces specification data. *Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39, Ill.*

▸ *INDUSTRIAL FANS* — in 6, 7, and 8 ft diameters covered in bulletin "E" with dimensional information, specification and application details and ordering information. *Monarch Electric Co., 137 W. Main St., New Britain, Conn.*

▸ *INDUSTRIAL HOT WATER* — manual provides industrial process application information, sizing charts, specifications and diagrams plus comparative fuel cost chart; with installation diagram section on various systems available. *Permaglas Div., A. O. Smith Corp., Kankakee, Ill.*

▸ *INDUSTRIAL INSULATIONS* — for sub-zero to 1900 F applications, of mineral wool, calcium silicates and other materials, block, blanket, felt, fill, cement and pipe insulation forms listed in new booklet; with selection chart, specification guide, illustrated application instructions. *Baldwin-Ehret-Hill, Inc., Industrial Insulation Div., 500 Breunig Ave., Trenton 2, N.J.*

▸ *INDUSTRIAL LOUVERS* — bulletin "IL-1" features company's line of curved return blade units which may be fixed or hand or motor operated; available in asbestos-asphalt coated metal. *Bowman Steel Corp., Box 2129, Pittsburgh 30, Pa.*

▸ *INDUSTRIAL NOISE CONTROL* — compilation of literature on new products including machinery enclosures, acoustic panels, sound isolation rooms, and others. *Industrial Acoustics Co., Inc., 341 Jackson Ave., New York 54, N.Y.*

▸ *INORGANIC INSULATION* — material composed of mica-reinforced glass said to incorporate properties of high dielectric strength, arc resistance, and no moisture absorption, described in new bulletin. *Haveg Industries, Inc., Taunton Div., 336 Weir St., Taunton, Mass.*

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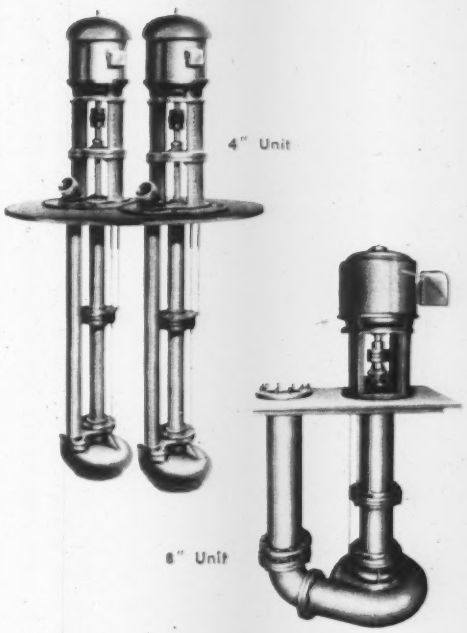

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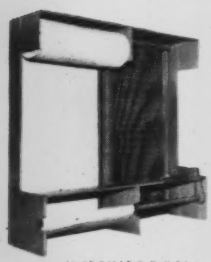
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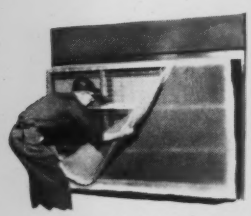
BLANKET Filtration eliminates frames, increases capacity 12-15%

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4776

(Where a washable, permanent filter is required, Microtron Corp. offers new MICRO-FOAM, a superior, acid and base resistant, plastic foam material with wide range of efficiencies and high dirt-loading characteristics.)

RECENT TRADE LITERATURE

Continued

▶ *LIQUID FILTERS* — and elements of stainless steel described in release "M-213A" with listing of stocked and non-stocked items, specifying methods, and outline of high pressure and other specialized filter characteristics. *Micro Metallic Div., Pall Corp., Glen Cove, N.Y.*

▶ *MACHINERY MOUNTS* — for vibration control, in 3 types detailed in new bulletin with data on loading ranges, vibration transmissibility, and "anchoring" properties of mounts. *Unisorb, Dept. WCH,* 210 *South St., Boston* 11, *Mass.*

▶ *MOTOR CONTROLS* — starters and contactors of "right angle" design said to feature reduced size and weight covered in brochure with illustrations of NEMA sizes 0 through 5; titled "½ The Size of Conventional Controls." *Arrow-Hart & Hegeman Electric Co., Industrial Control Div.,* 103 *Hawthorn St., Hartford* 6, *Conn.*

▶ *PACKAGED AIR CONDITIONERS* — in single or multi-zone units described and illustrated in bulletin "8625" with line drawings illustrating available arrangements and basic element locations and dimensional and specification tabulations. *American-Standard Industrial Div., Detroit* 32, *Mich.*

▶ *PACKAGED AIR CONDITIONERS* — for motels, employing hydronic heating and cooling featured in illustrated sheet with typical motel layout, electrical wiring and piping diagrams. *Edwards Engineering Corp.,* 101 *Alexander Ave., Pompton Plains, N.J.*

▶ *PACKAGED BOILERS* — bulletin "4010" describes "on-off" type water tube unit for operations not requiring full modulating equipment. *Vapor Heating Corp.,* 80 *E. Jackson Blvd., Chicago* 4, *Ill.*

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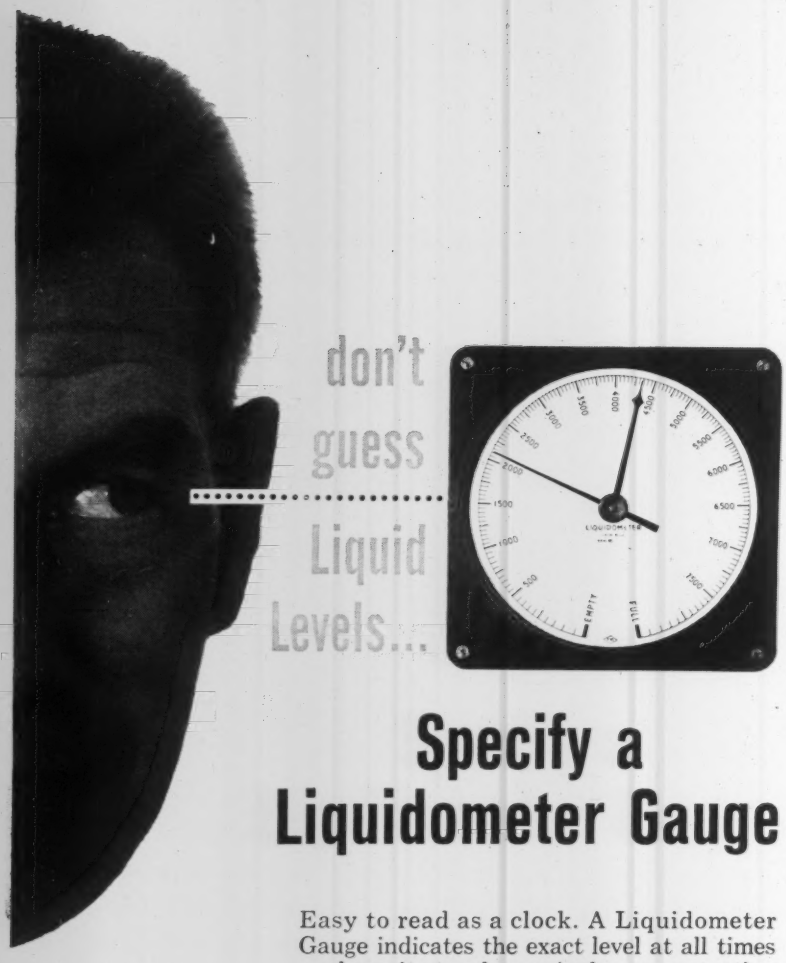

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Whether your gauging needs require an automatic Liquidometer Gauge, a hydrostatic Levelometer or a tank-site-indicating Direct Reader, you'll get the best by specifying Liquidometer. For complete details write Dept. A.

Since 1920 ...of proven quality

THE LIQUIDOMETER CORP.

LONG ISLAND CITY 1., NEW YORK

RECENT TRADE LITERATURE

Continued

▶ *PACKAGED BOILERS* — in high and low pressure models, 20 to 100 hp, oil, gas, or combination fired, detailed in bulletin with description of hot water units designed for forced circulation applications; ratings, sizes, and approximate fuel consumption for all sizes included. *Orr & Sembower, Inc., Box 1138, Reading, Pa.*

▶ *PACKAGED BOILERS* — Scotch fire tube type described in bulletin with cut-away illustration, ratings and dimension tables, short discussion of efficiencies and operating characteristics of 3-pass, low pressure design. *Burnham Corp., Steel Boiler Dept., Irvington, N.Y.*

▶ *PIPE INSULATION* — for corrosion resistance requirements, comprised of several products detailed in bulletin with pipe coverage table, application instructions. *Chase & Sons, Inc., 26 Spruce St., North Quincy, Mass.*

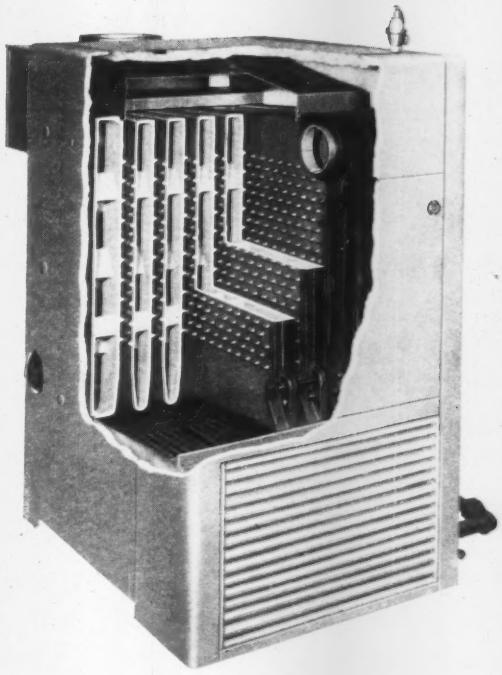
▶ *PIPE FITTING INSULATION* — bulletin "TD-105" describes features of molded glass fiber material that provide thermal insulating advantages; with cold, hot, and low-pressure line relative insulation thickness tabulations, insulation specifications, and dimensional data. *Fibrous Glass Products, Inc., Alpa Plaza, Hicksville, L.I., N.Y.*

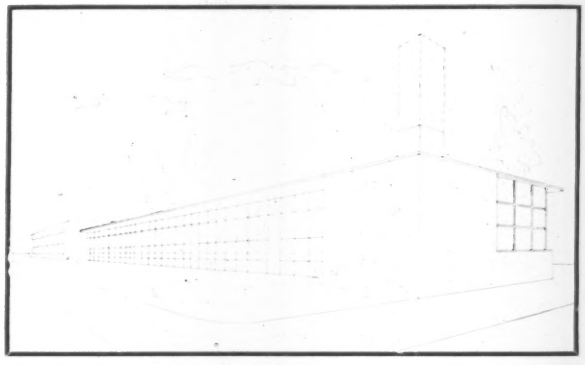
▶ *PIPING SUPPORTS* — system using standard components for application in power, nuclear, and other industries described in booklet with details on hangers, roller devices, standard assembly parts; system said to effect labor savings on piping 3 in. in diameter and larger. *Bergen Pipesupport Corp., 50 Church St., New York, N.Y.*

SAVES IN THREE IMPORTANT WAYS

The Weil-McLain Type "J" Gas Boiler invites your critical comparison...for outstandingly efficient design, space conservation, easy installation, low maintenance and long life. A few of its many features include:

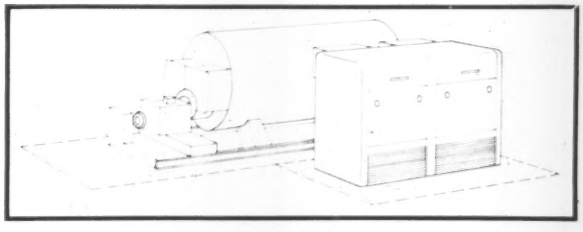
1. Made of corrosion-resistant cast iron—with finned sections—internal steam separators—large flow tappings.
2. A.G.A. approved efficiency of 80%...approved for all gases.
3. Develops full capacity as rated by A.G.A. and I-B-R.
4. Available with A.G.A. approved dual fuel manifold.
5. Electronic controls and pre-wired control panels engineered as part of unit.
6. No refractories, no motors or fans, no tube replacement, no water treatment.
7. Wide range of sizes permits close sizing to load.





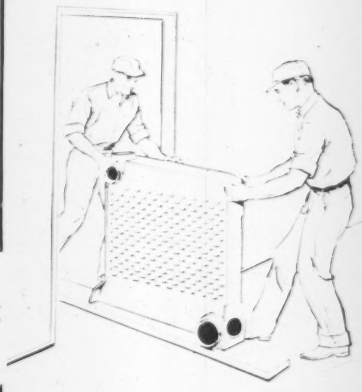
SAVES A CHIMNEY

A high chimney, forced draft or induced draft are not necessary for the proper operation of the "J" Boiler. All "J" Boilers can operate with a vent.



SAVES SPACE

Sketch shows the space saved by a 60 H.P. Type "J" Boiler over a typical scotch marine boiler of comparable rating. It is approximately one half as long, one foot less in height and only a few inches greater in depth, including space necessary for the draft hood. The required service area is smaller...and appreciably smaller if tube replacement is to be made through the rear door of the scotch marine boiler.



SAVES TIME AND LABOR

Sectional design of "J" Boiler is more flexible. For either new or replacement work, the boiler can be moved in through an ordinary door, section by section, at any time during construction. Assembly with short draw rods simplifies erection...saves labor...assures freedom from stresses and strains.

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TYPE "J" CAST IRON GAS BOILERS

Net I-B-R Capacities:
360,100—3,354,000 BTU per hr.

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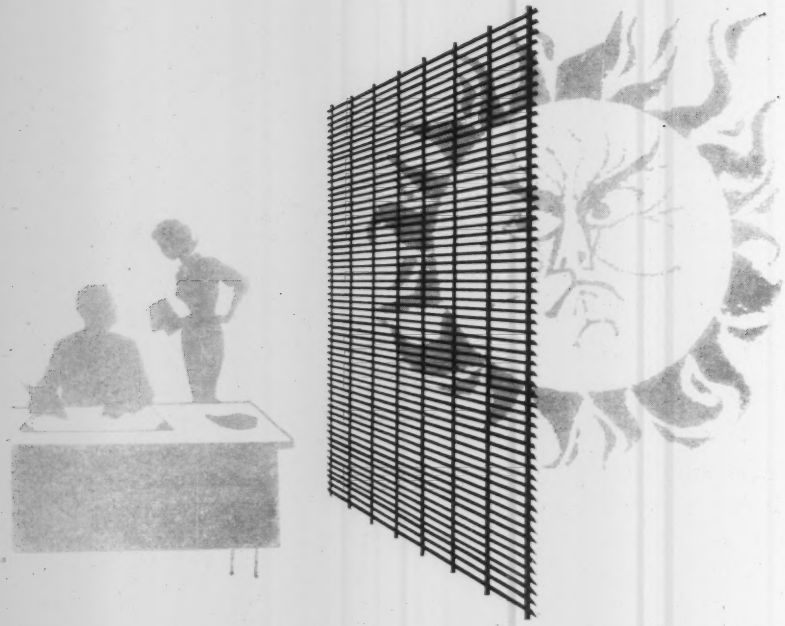

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cuts air conditioning costs

For every 100 square feet of KoolShade Sunscreen installed on the outside of windows, air conditioning cooling loads can generally be reduced by one ton. This will mean substantial savings when new air conditioning installations are being considered... greatly reduced operating costs for existing systems.

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▶ *PLANT EQUIPMENT* — including reciprocating, axial-flow, and centrifugal compressors, centrifugal pumps, steam condensers, steam ejectors, vacuum pumps and other items described in booklet, form "223" with illustrations, recommended applications, size and capacity ranges. *Ingersoll-Rand Co., 11 Broadway, New York 4, N.Y.*

▶ *PNEUMATIC VALVES* — bulletin "HB-7" gives construction details, operating characteristics and specifications plus valve sizing and flow-coefficient section for line of pneumatically actuated valves, including springless diaphragm, cylinder, and spring-and-diaphragm types for on-off or throttling control applications. *Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

▶ *POWER TOOLS* — for contractor use described in catalog which covers complete available line. *Skil Corp., 5033 Elston Ave., Chicago 30, Ill.*

▶ *PREFABRICATED COILS* — for heating and cooling applications described in bulletin "M-9" with examples of tank, mixers, air duct installations. *Dean Products, Inc., 1048 Dean St., Brooklyn, N.Y.*

▶ *PRESSURE METER* — non-indicating, for line connection operation of potentiometric or current-operation recorders or controllers described in data sheet "EIL 28 AM"; meter is said to provide stability of ±0.02 pH in 24 hours, ±0.1 pH indefinitely. *Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.*

▶ *PROPELLER FANS* — of low-speed, high-volume design in 65 to 94 in. sizes, 174,000 cfm maximum discharge, belt, direct, or pulley drive models described in bulletin "A-109E" with dimensions, specifications, and performance data. *Hartzell Propeller Fan Co., P.O. Box 909, Roosevelt Ave., Piqua, O.*

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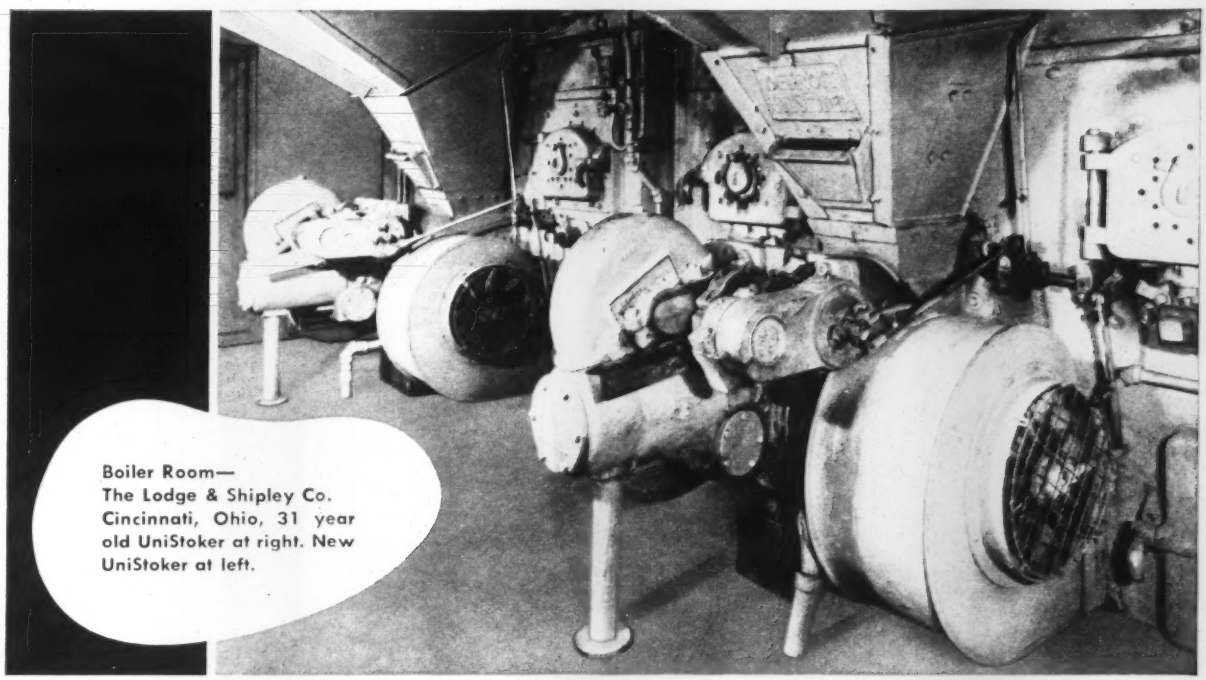

Boiler Room—
The Lodge & Shipley Co.
Cincinnati, Ohio, 31 year old UniStoker at right. New UniStoker at left.

● A Detroit UniStoker installed at The Lodge & Shipley Co., Cincinnati in 1927 performed so well and proved the economy of UniStoker firing so conclusively that another UniStoker was purchased in 1958 when added steam capacity was needed to serve plant expansion.

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YOU can save with Detroit Stokers. Let one of our sales Engineers recommend the correct stoker for your needs.

The Complete Detroit Line of Underfeed and Overthrow Spreader Stokers provides a type and size for almost any boiler from 3,000 to 400,000 pounds of steam per hour capacity.

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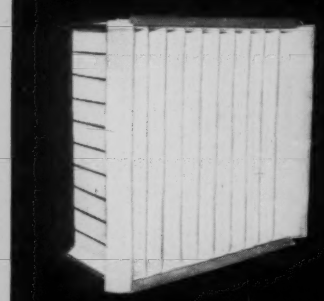

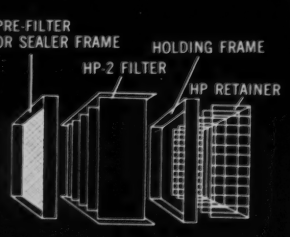

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RECENT TRADE LITERATURE

Continued

▸ *RADIANT HEATERS* — for outdoor area applications exemplified in brochure "CS-306" with description of infra-red principles and catalog of available gas-fired units; specifications and heating capacities included. *Perfection Div., Hupp Corp.*, 1135 *Ivanhoe Rd., Cleveland* 10, *O.*

▸ *REFLECTIVE INSULATION* — for industrial applications explained and illustrated in booklet "The Story of Reflective Insulation" with explanation of heat transfer, thermal efficiency and condensation, plus tabular comparisons of various insulation materials. *Reflectal Corp.*, 200 *S. Michigan Ave., Chicago* 4, *Ill.*

▸ *ROTARY SOLENOIDS* — basic information sheet illustrates torque, stroke speed, types of strokes, power take-off and sizes as applied to manufacturer's available units. *Ledex, Inc.*, 123 *Webster St., Dayton* 2, *O.*

▸ *SILICONES* — and various uses for adhesive, laminating, repellent, and insulation effects detailed in brochure with photographs, tables and graphs for simplified specification information. *Dow Corning Corp., Midland, Mich.*

▸ *SPACE HEATERS* — in wide variety of models, capacities, mounting capabilities listed in catalog with dimensional drawings, description of special features. *Arkos Mfg. Co.*, 7310 *Woodward Ave., Detroit* 2, *Mich.*

▸ *SUBMERSIBLE PUMP MOTORS* — brochure "F-2000" contains cutaway drawings of 6, 10, and 14 in. well diameter models employing water-filled principle and hermetically sealed windings. *U.S. Electrical Motors, Inc., P.O. Box* 2058 *Terminal Annex, Los Angeles* 54, *Calif.*

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STYLES VE-RC and **VE-MC** are furnished with "Holedall" Pressed-on Couplings—attached as integral parts of the hose to provide the finest leak- and pressure-proof assemblies available.

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STYLE VE-M. Unit consists of a length of all-metal bronze hose, bronze laced, with two standard copper tube "slip-fittings" welded on. Also available with bronzed or welded-on nipples, unions or flanges. Can be furnished in any required length and in tube sizes from 3/16" to 8" I.D.

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RECENT TRADE LITERATURE

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▶ *THERMOCOUPLE CONNECTORS* — for use where periodic connection or disconnection of thermocouple extension wire is required featured in specification "FS005-3" with list of various components and description of each. *Minneapolis-Honeywell Regulator Co., Penn and Bay Sts., Fall River, Mass.*

▶ *THERMOSTAT METAL STACKING* — for satisfaction of performance requirements in space that prohibits use of large-volume single element described in data bulletin "TRU-11" with discussion of series, parallel, and parallel-series stacking, rules for determining thermal and mechanical deflection. *General Plate Products Group, Metals & Controls Div., Texas Instruments, Inc., 34 Forrest St., Attleboro, Mass.*

▶ *THERMOSTATS* — for industrial and commercial electric heater control illustrated and described in bulletin "R55100" with size, finish, and electrical rating data, and wiring diagrams. *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

▶ *TUBULAR GOODS* — price books for items including standard pipe with dated indices and price pages; in 3-ring or spiral bound form. *The Youngstown Sheet and Tube Co., P.O. Box 900, Youngstown 1, O.*

▶ *VACUUM GAGES* — catalog "175" features single and twin meter types, controllers, battery operated units, and recorders, with operation and characteristics discussed. *Hastings-Raydist Inc., Hampton, Va.*

▶ *VENTILATION PRODUCTS* — plastic, for use in corrosion resistant applications, including round and rectangular fume ducts, fittings, hoods, centrifugal and axial flow fans, roof ventilators, tanks, scrubbers, and sheet-cementing kits; bulletin "B-500", *Heil Process Equipment Corp., 12901 Elmwood Ave., Cleveland 11, O.*

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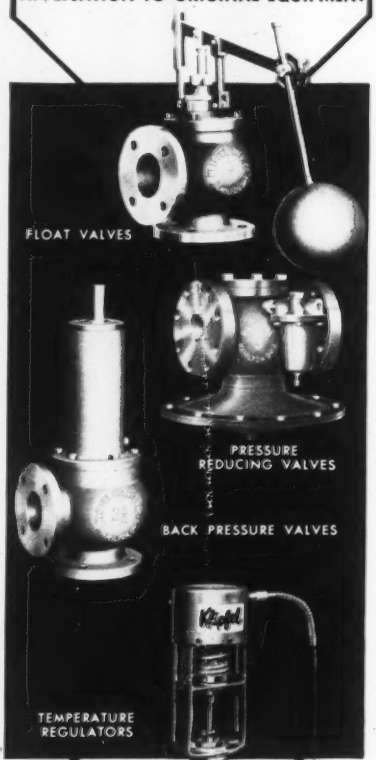

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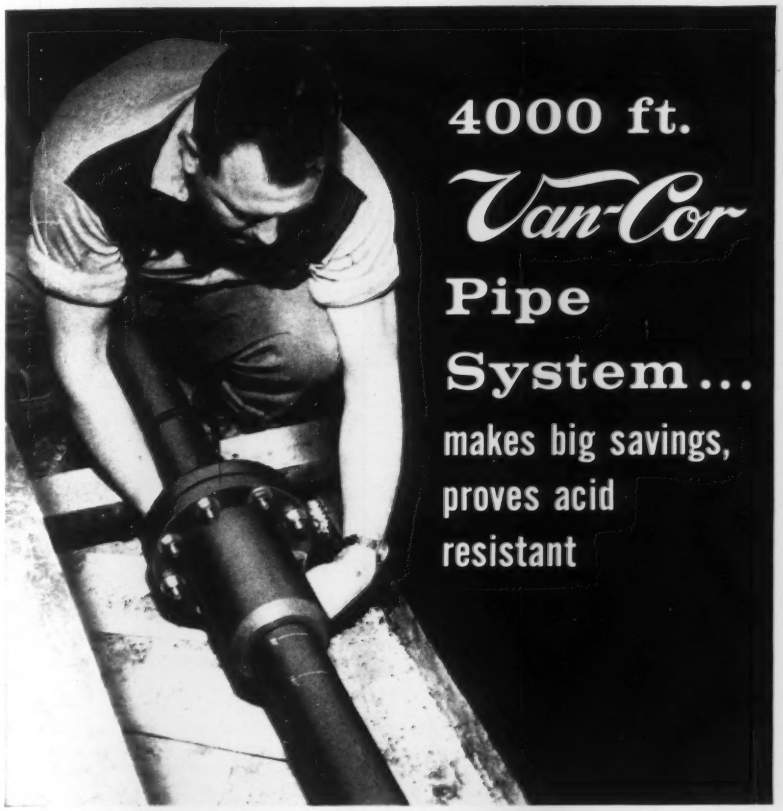

4000 ft. Van-Cor Pipe System... makes big savings, proves acid resistant

At the Allentown (Pa.) Works of the Western Electric Co., the entire waste acid disposal system in the recent addition consists of Van-Cor rigid PVC pipe and fittings.

HOW COSTS WERE CUT. Initial price of Van-Cor was ⅓ that of comparable cast iron alloy pipe. On a 6" line, labor costs were estimated at 29¢ per foot of run—about half that of metallic pipe. Also, because Van-Cor has only 1/10 the weight, no mechanized handling equipment was needed. Available in 10 or 20 ft. lengths, Van-Cor requires fewer joints, and eliminates the breakage problem.

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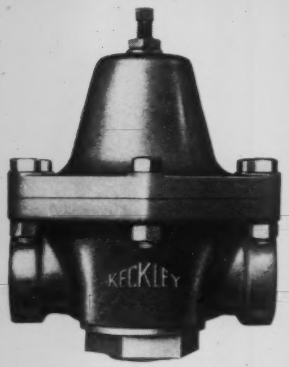

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The new Keckley No. 11A and No. 11R pressure reducing and relief valves feature a full ported orifice for greater capacity and increased flow of steam, air, water, oil and gas applications.

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AN AIR conditioned suit, capable of providing a comfortable environment for the wearer in temperatures ranging from −40 F to +135 F is being developed for the U. S. Naval Supply, Research and Development Facility, Bayonne, N. J., by Westinghouse Electric Corp.

The lightweight insulated garment will be equipped with a battery-powered thermoelectric heating-cooling unit, plus a built-in blower system for air circulation inside the suit. By reversing the direction of current flow through small elements of a solid semiconductor material, either heating or cooling effect will be provided to compensate for outside temperature conditions. The rechargeable batteries reportedly will provide current for a minimum of 1 hour's use, and in addition, the suit will be designed so that it may be plugged into an external power source when available.

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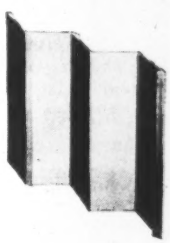
Demand the best! Costs no more. Maintenance costs are negligible as the superior surface of SOPLASCO blades reduce to a minimum the accumulation of algae and lint. Cleaning is accomplished without blade removal.



Southern Plastics Co.

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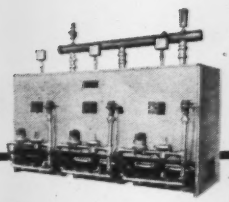
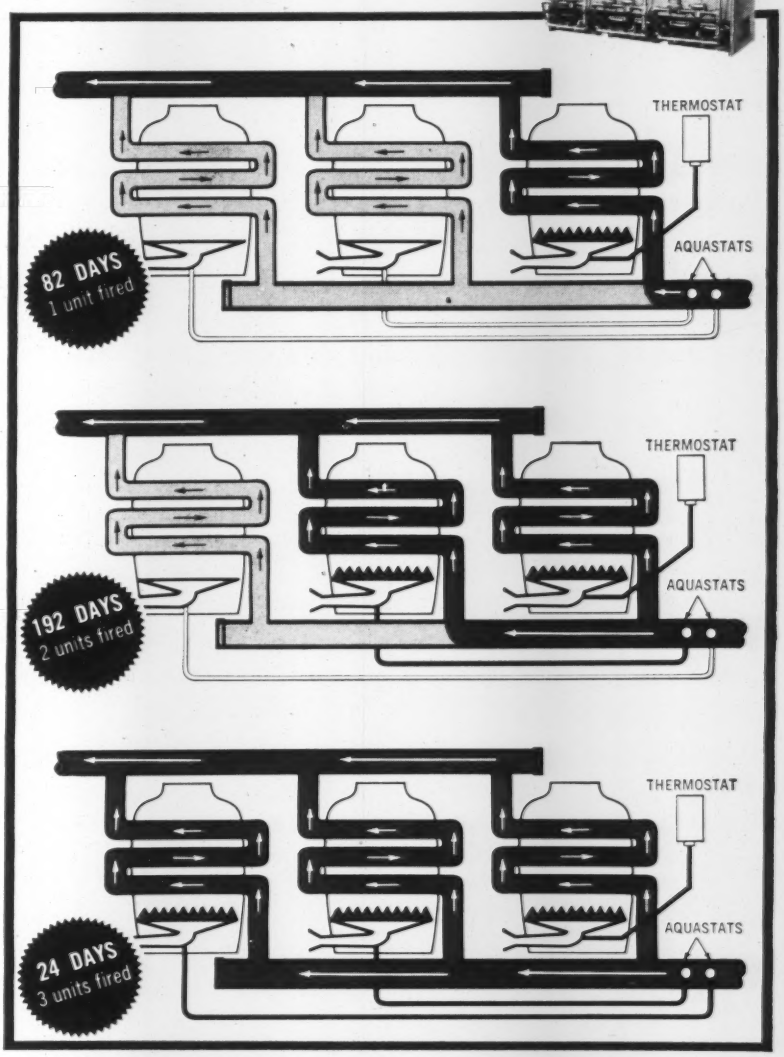
Columbia, S. C.

For further information write, wire, or phone SOPLASCO AIR PRODUCTS DEPT.

See How MULTITEMP Saves Money on Big Gas Jobs





CUTS SHORT CYCLING. FUEL WASTE. INSTALLATION COSTS

Diagram shows how cast iron MULTI-TEMP Hot Water Heating Plants automatically adjust capacity to load — save fuel dollars! Sensing elements in return water header call in additional combustion units, one-by-one, as temperatures drop. The load distribution shown is typical of our northeastern region. Note: full capacity was required during only 3% of heating season, and a single unit could meet demand for over 25% of season. Set-up time is saved too — batteries do not require field rigging or joining of sections — come factory assembled with controls. Maintenance is easy on individual units without service interruptions. Capacities up to 3,600,000 BTU/hr., rated at 100# ASME working pressure. For space heating and volume water heating. *Write for catalog HY-F107 today!*

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MERCOID® CONTROLS

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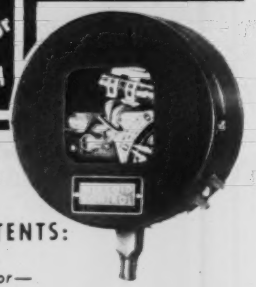


CONTENTS:

Controls for—

- PRESSURE
  TWO-STAGE PRESSURE
  DIFFERENTIAL PRESSURE
- TEMPERATURE
  TWO-STAGE TEMPERATURE
- LIQUID LEVEL
- MECHANICAL MOVEMENT
  LEVER ARM AND
  FLOAT OPERATED
- TRANSFORMER-RELAYS
- MERCURY SWITCHES
  HERMETICALLY SEALED

CATALOG NO. 860

THE MERCOID CORPORATION
4205 BELMONT AVENUE
CHICAGO 41, ILL.

IT'S EASY
TO SELECT A
CONTROL FOR
ANY APPLICATION
WHEN IT'S A
MERCOID®

WE HEAR THAT...

▶ *H. K. PORTER & CIE S. A.*, international subsidiary of *H. K. PORTER Co., INC.*, has acquired 51 per cent of the stock of *KING AIRCRAFT CORP., LTD.*, Glasgow, Scotland, manufacturer of flexible metallic hose.

▶ *AIR REDUCTION PACIFIC CO.*, div. of *AIR REDUCTION CO., INC.*, has dedicated a new $3 million liquid air separation plant in Richmond, Calif.

▶ *BORG-WARNER CORP.* has announced the formation of *BORG-WARNER CONTROLS DIV.*, at Santa Ana, Calif., to take over personnel, products, and facilities of the Corp.'s BJ electronics plant.

▶ *CONTROLS CO. OF AMERICA* has contracted to acquire a former *CHAIN BELT CO.* Milwaukee ordnance plant and adjoining land and will transfer manufacturing operations from its 31st St. plant to the new location.

▶ *COLVIN LABORATORIES, INC.*, has announced the formation of a new company, *PRESSURE ELEMENTS, INC.*, for the production of pressure diaphragms and capsules.

▶ *ARMCO DRAINAGE & METAL PRODUCTS, INC.*, will build a half-million dollar plant at Hillsboro, Ore., to produce corrugated metal pipe.

▶ Walter H. Wiewel has retired from service as senior vice president, *CRUCIBLE STEEL CO. OF AMERICA*, but will continue association with the company as a consultant.

▶ *RHOPAC, INC.*, has acquired the *SPRING PACKING CORP. INDUSTRIAL DIV.*

Install Insulation with
TUFF-BOND
Super-Strength Adhesives

TUFF-BOND #7
... fire-retardant adhesive for installing insulation

TUFF-BOND M-102-H
... economical duct liner adhesive

TUFF-BOND 21-C
... clear lap sealer and lap adhesive

TUFF-BOND 21-W
... white lap sealer and lap adhesive

TUFF-BOND #500
... exceptionally high-strength chemical-set adhesive with wide thermal range −100° F. to 350° F.

TUFF-BOND #1000
... high heat resistance for bedding and installing high temperature insulation

TUFF-BOND #12
... high pressure duct sealer

TUFF-BOND QUIK-SET
... neoprene-base, fast-setting adhesive. Recommended for installing metal and nylon hangers to smooth surfaces.

TUFF-BOND GENERAL PURPOSE IMPROVED
... all-around adhesive for installing insulation, insulation hangers, etc.

Ask for descriptive literature and prices.

GOODLOE E. MOORE
INCORPORATED
DANVILLE 26, ILLINOIS

WE HEAR THAT

Continued

▶ *PALL CORP.* has completed a 7600 sq ft engineering and management addition at its main office in Glen Cove, N.Y.

▶ *LIMBACH CO.*, Pittsburgh mechanical and metals contractor, has acquired the *GEORGE H. SOFFEL CO.*, Pittsburgh heating, piping, and air conditioning firm.

▶ *THE FLINTKOTE CO.* has entered into formal agreement for the acquisition of *HARRY T. CAMPBELL SONS' CORP.* of Baltimore, Md., a manufacturing and contracting firms

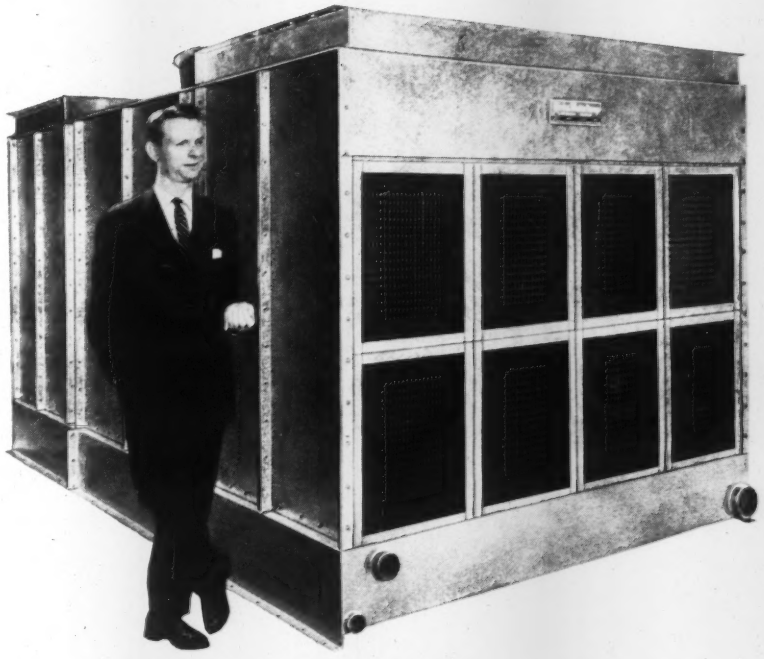
▶ *PITTSBURGH COKE & CHEMICAL CO.* has consolidated its three chemical divisions into *PITTSBURGH CHEMICAL CO.*, a wholly owned subsidiary.

▶ *THE ATOMIC ENERGY COMMISSION* has issued plans and specifications for the construction of the Mobile Low Power Reactor No. 1 Test Facility at the National Reactor Testing Station, Idaho, to cost approximately $250,000. The support facility will consist of test and auxiliary control buildings.

▶ *BUENSOD-STACEY CORP.* has been formed following merger of *BUENSOD-STACEY INC.* with *AERONCA MFG. CORP.*

▶ *POWERS REGULATOR CO.* has acquired controlling interest in *THE GROVER CO.*, Detroit pneumatic tube transmission system manufacturer.

▶ Walter B. Simpson, *A. M. BYERS CO.*, St. Louis div. manager, has retired after 10 years service with the firm.



New HEAVY DUTY Watertemp® cooling towers

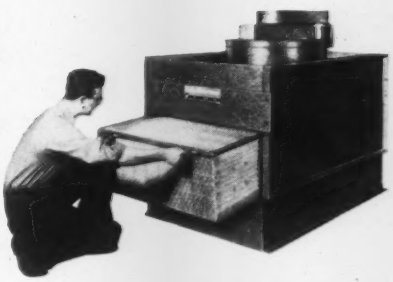
with removable plastic decking

New cooling capacity
- available in 80, 100, 150, 200, 250 and 300 ton units

New assembly ease
- no nozzles or complicated header piping
- no cutting or fitting
- no painting required

New maintenance ease
- plastic decking slides out for fast, easy clean-up
- no maintenance painting

New tower life
- all sections hot-dipped galvanized after fabrication to leave no toe-hold for rust or corrosion attack.
- propeller fan is of alloy steel
- ball bearing weatherproof motor runs smoothly and gives trouble free performance

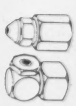


Watertemp cooling towers are also available in the 5 to 60 ton cooling ranges. Plastic decking slides out for cleaning and maintenance.

Send for free bulletins
For 80 to 300 ton capacity towers ask for Bulletin WT 508. For 5 to 60 tons, ask for our Bulletin WT 501.

0203

Binks
EVERYTHING FOR WATER COOLING



A COMPLETE LINE OF NATURAL DRAFT AND MECHANICAL DRAFT COOLING TOWERS AND INDUSTRIAL SPRAY NOZZLES

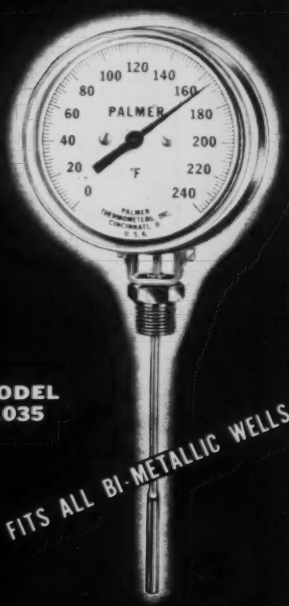
Binks Manufacturing Company
3118-38 Carroll Ave., Chicago 12, Ill.

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

Outstanding Accuracy

PALMER

Dial Thermometer



Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

WE HEAR THAT

Continued

▶ *CHASE BRASS & COPPER CO.*, subsidiary of *KENNECOTT CORP.* will spend in excess of $2 million to develop an automatic tube rolling process at its Waterbury, Conn., plant.

▶ *RHEEM SEMICONDUCTOR CORP.* has formally opened its new $2 million plant near San Francisco, Calif.

▶ *RANCO CONTROLS, CANADA, LTD.*, wholly owned subsidiary of *RANCO INC.*, will manufacture automatic control devices for Dominion distribution.

▶ *UNITED ASSOCIATION*, national labor organization of steamfitting and pipefitting trades, has accepted membership in the *BETTER HEATING-COOLING COUNCIL*.

▶ *G. H. LELAND, INC.*, has changed its corporate name to *LEDEX, INC.*

▶ Capital expenditures of *THE B. F. GOODRICH CO.*, for new and improved facilities and equipment will approximate $50 million in 1960, largest in the company's history.

▶ *GREGORY INDUSTRIES, INC.* has announced its entry into the powder actuated tool manufacturing business, to be handled through its newly established Nelson Stud Driver Div., and 5 recently purchased regional stud driver distributors.

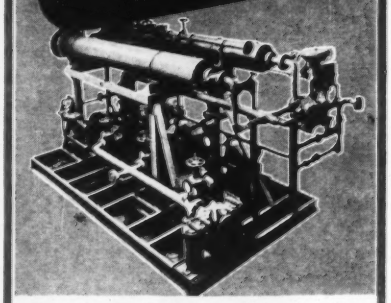
▶ *HOOKER CHEMICAL CORP.* has transferred its corporate headquarters to 666 Fifth Ave., New York 19, N.Y.; headquarters for the firm's Eastern Chemical, Western Chemical, Durez Plastics, and Phosphorus divisions will remain at Niagara Falls, Tacoma, North Tonawanda, N.Y., and Jeffersonville, Ind., respectively.

save on installation and maintenance

with

EAGAN

FUEL OIL PUMP and HEATER SETS



Use an Eagan "pre-packaged" fuel oil pump and heater set for the preparation of heavy oil for combustion. You save time and money because units are completely assembled, ready for immediate installation. Only connections to oil and steam supply, burner, by-pass and relief lines have to be made and you avoid the combustion difficulties so often caused by field assembled combinations.

Here are additional benefits Eagan gives you:

- Generous reserve capacity, at least 50% over peak burner demand, allows for eventual wear and future demand-increases.
- Maintenance is easy and at a minimum. Parts requiring service are easily accessible.
- "Honest", solid construction, excellent engineering assure long life, trouble-free operation.
- Compact units save space.

EAGAN fuel oil pump and heater sets heat to 300° F, pump to 400 psi and have capacities to 3000 gph. Single or duplex units are available for steam or electric drive. Duplex "electro-steam" sets provide for electrical failure by incorporating one steam pump and one electric motor driven pump. Other EAGAN sets can be made to your special requirements.

Write, wire or call for further information or let us bid on your job.

WALTER H. EAGAN CO., INC.

2337 Wallace Street, Phila. 30, Penna.

CEnter 6-2300

Mfrs. of condensate, boiler feed, turbine, centrifugal and proportioning pumps and fuel oil pump and heater sets.

Pump Specialists Since 1920

WE HEAR THAT

Continued

▶ *BORG-WARNER CORP.* will invest a record $34 million in domestic and foreign facility, machinery, and equipment expansion in 1960.

▶ *FLEXONICS CORP.* has begun construction of headquarters general offices, manufacturing and research facilities in Bartlett, Ill.

▶ *PUNCH PRODUCTS CORP.* has moved its facilities to 370 Babcock St., Buffalo 6, N.Y.

▶ Leo E. Starr, manager of *CARRIER CORP. MARINE DEPT.*, has retired after 37 years of service with the firm.

▶ *FISHER GOVERNOR CO.* has begun operations in its "White Room" facility for process and assembly of nuclear and cryogenic control equipment.

▶ *CHRYSLER CORP., AIRTEMP DIV.*, has established national network of 13 parts depots to furnish replacement parts to dealers, contractors, and industrial users.

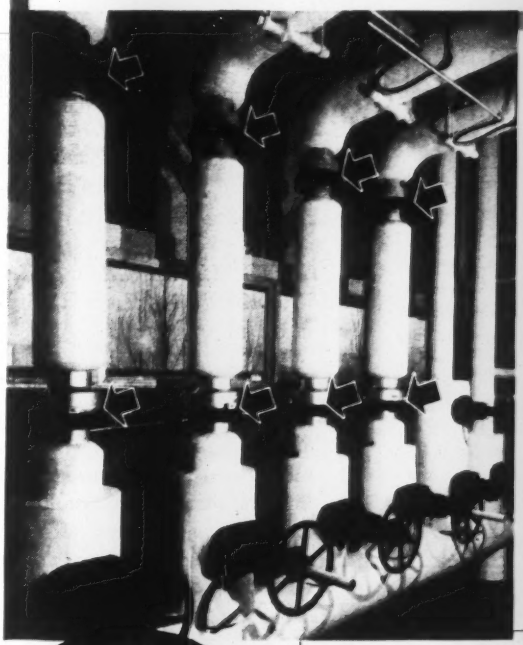
▶ James S. Vanick, research metallurgist with *THE INTERNATIONAL NICKEL CO., INC.* development and research div., has retired after 38 years with the firm.

▶ *MANNING, MAXWELL & MOORE* has announced formation of a gage and instrument div. and a valve div.

▶ *W. S. ROCKWELL CO.* has announced the establishment of a plastics coating div.

▶ *CUTLER-HAMMER, INC.*, has revealed plans for the construction of new manufacturing, sales office, and warehouse facilities in Belmont, Calif.

Barco Solves Boiler Piping Expansion Problem



Relieves Strain on Valves

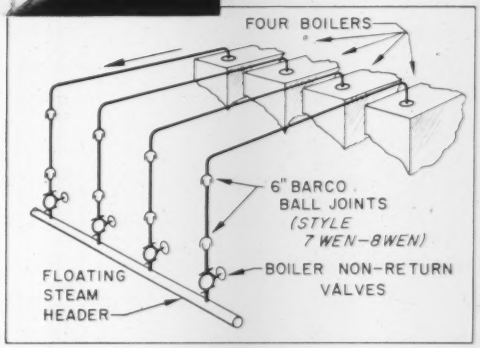
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the non-return valves.

BARCO

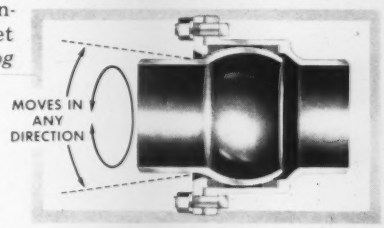
BALL JOINTS

1. **Handle Expansion**
2. **Relieve Torsion**



PROBLEM—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

ANSWER—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*



BARCO MANUFACTURING CO.
5411 Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

Babbitt

Adjustable
SPROCKET RIM
with Chain Guide
Changes that Danger Zone to a
SAFETY ZONE

The distance between the floor of your plant and your overhead valves is a DANGER ZONE when piled up boxes or even ladders are used to reach the valves.

Turn it into a SAFETY ZONE — equip your overhead valves with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. If your supplier does not carry them, contact us direct.

Babbitt 168-9

STEAM SPECIALTY CO.

8 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

WHO'S WHAT . . .

▶ *L. B. FOSTER CO.* — J. R. McCutcheon, Jr., manager, valve and fitting sales; Robert M. Crawford, manager, pipe sales.

▶ *PEERLESS PUMP DIV., FOOD MACHINERY AND CHEMICAL CORP.* — John D. Nommensen, process pump product sales manager.

▶ *NATIONAL MINERAL WOOL ASSOCIATION* — Fred H. Sides, executive officer.

▶ *GAS APPLIANCE MANUFACTURERS ASSOCIATION* — new officers for Gas Equipment Manufacturers' Program: chairman: Edward C. Hemes, vice president of Vulcan Rubber Products Div., Reeves Brothers, Inc.; vice chairman; Paul C. Kreuch, vice president of Rockwell Mfg. Co.

▶ *UNI-FLEX MFG. AND ENGINEERING INC.* — Edward L. Maguire, manager of cryogenics.

▶ *YORK DIV., BORG-WARNER CORP.* — Edward M. Haines, vice president and assistant to the president.

▶ *BELL & GOSSETT CO.* — Alfred B. Meeg, vice president, sales; Arthur T. Woerthwein, vice president, finance.

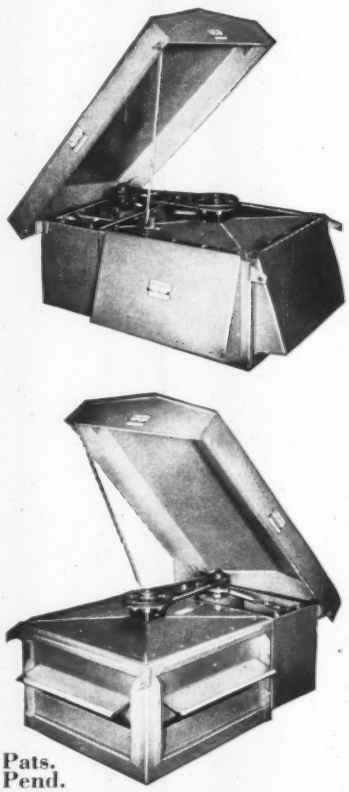
▶ *GREGORY INDUSTRIES, INC.* — Rowland Knopf, manager, Nelson Stud Driver Div.

▶ *WATKIN & CO.*, Mechanical Contractors—Henry Kleinkauf, executive chairman, board of directors; Henry Gould, president and treasurer.

AirMpeler

LO-BOY
CENTRIFUGAL ROOF EXHAUSTERS

Enhance the Beauty of Building Skylines



Pats. Pend.

Lowest Silhouette Design

Forward or Backward Curve Wheel Within . . . . or Out of Scroll Housing

Motor mounting on side of structure support . . . out of line of air stream reduces height of Lo-Boy models nearly 50% of older designs.

LOW WIND RESISTANCE
SIZES 10"-72" 600-47,000
CERTIFIED C.F.M. RATINGS

- **QUALITY** • **BEAUTY**
- **PROVEN PERFORMANCE**

Write for bulletin Ha-100 60

AMMERMAN CO., INC.

P.O. Box 182
Stillwater, Minnesota
MEMBER OF THE AIR MOVING & CONDITIONING ASSN.

WHO'S WHAT

Continued

▶ *"AUTOMATIC" SPRINKLER CORP. OF AMERICA* — R. J. Buchanan, manager, special hazards dept.

▶ *AURORA PUMP DIV., THE NEW YORK AIR BRAKE CO.* — Michael A. Prigmore, controller.

▶ *DOLE VALVE CO.* — Gerald E. Veino, manager of product forecasting and sales analysis.

▶ *THOR POWER TOOL CO.* — Peter Rebechini, chief engineer, Aurora Works.

▶ *FEDDERS CORP.* — Constantine Keen, credit manager.

▶ *CLAY FLUE LINING INSTITUTE* — L.E. Hoyt, Worthington Ceramics Co., secretary.

▶ *RUSSELL, BURDSALL & WARD BOLT AND NUT CO.* — James M. Dill, special products sales manager.

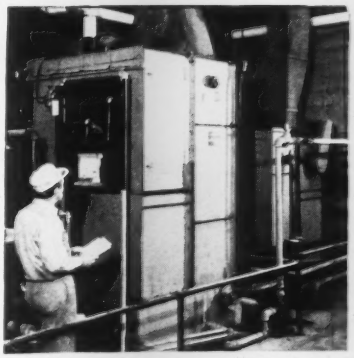
▶ *SAMUEL MOORE & CO.* Arthur O. Grumney, assistant sales manager, Dekoron Products Div.

▶ *FRIEZ INSTRUMENT DIV., BENDIX AVIATION CORP.* Arthur S. Pawling, factory manager; E. R. Harrell, director of product quality.

▶ *COPELAND REFRIGERATION CORP.* — Raymond G. Mozley, vice president, overseas operations.

DRY and CLEAN AIR at the RIGHT TEMPERATURE

- to control your product quality
- to protect a critical operation
- to protect apparatus from moisture damage
- to DRY your material or product
- to control packing or storage conditions
- to assure precision in testing or research
- to increase air conditioning capacity



Air Condition by the NIAGARA Method Using HYGROL Liquid Absorbent

This compact method, giving high capacity in small space, removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the air.

Most effective because... it removes moisture as a separate function from cooling or heating and so gives a precise result, and always. Niagara machines using liquid contact means of drying air have given over 20 years of service. The apparatus is simple, parts are accessible, controls are trustworthy.

Most reliable because... the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions... no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

Most flexible because... you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

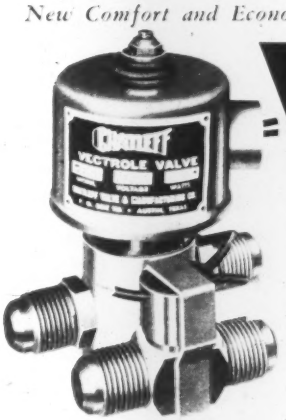
Write for Bulletins 112 and 131 and complete information on your air conditioning problem.

NIAGARA BLOWER COMPANY

Dept. HP-5, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

New Comfort and Economy For Individual Forced Air Convectors.



The Vectrole
Water Diverting Valve

gives you year 'round comfort automation at a reasonable price. The Chatleff Vectrole Valve, Switching Element and Thermostat give you a complete comfort control system at a tremendous saving.

Please send me complete information on the Chatleff Vectrole Valve.

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Address _____ City _____

CHATLEFF

VALVE & MANUFACTURING CO.

205 Industrial Blvd. Austin 4, Texas

Heating and Air Conditioning

PRESSURE MEASUREMENT

ASHCROFT GAUGES DO THE JOB *ACCURATELY*

Ashcroft Duragauge in Phenol Case

Name the operational pressures of any heating, piping or air conditioning equipment you specify, install or service: There's an Ashcroft Gauge to measure the pressures precisely—from 30" vacuum or a few ounces to the highest psi used on any system. That is why Ashcroft Gauges are used on everything from giant boilers to small compressors.

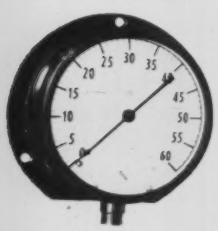
You have a choice of three classes of Ashcroft Gauges. Each class has functional characteristics compatible with its recommended applications.

DURAGAUGES: The finest pressure gauges you can specify and install on any heating, piping or air conditioning system. Highest sustained accuracy and durability assure savings in replacements and repairs far exceeding the initial investment.

QUALITY GAUGES: Second only to the Duragauge in ruggedness and sustained accuracy. Ideal for the normal industrial, commercial and institutional equipment.

STAINLESS STEEL CASE GAUGES: The best gauges for small compressors, pumps, boilers and the less important pressure lines. Inexpensive but accurate and durable.

Whatever the medium under pressure—air, oil, water, steam, or refrigerant—select Ashcroft Gauges. Pressure, vacuum and compound ranges available. Several dial sizes. *Write for Catalog 300B.*



Ashcroft Quality Gauge in Alumalife® Case. Catalog No. 1010.

Ashcroft Gauge in Stainless Steel Case. Catalog No. 1000.

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

WHO'S WHAT

Continued

▸ *ALPHA METALS, INC.* — Harold A. Cohn, vice president in charge of Alpha-Loy Div; Frederick C. Disque, Jr., director of research.

▸ *THE VILTER MFG. CO.* — Herman C. Melms, manager, order department.

▸ *DELAVAN MFG. CO.* — J. David Hopkins, vice president in charge of sales.

▸ *UTILITY APPLIANCE CORP.* — Richard Petersen, chief engineer for research and advanced development engineering.

▸ *A. M. BYERS CO.* — H. K. Siefers, Jr., manager, engineering service department.

▸ *BORG-WARNER CORP.* — Arthur J. Welch, president and general manager, Spring Div.

▸ *ARMCO STEEL CORP.* — Russell N. Nein, superintendent, Middletown, O., cold strip mill.

▸ *ANSUL CHEMICAL CO.* — James A. Bowman, advertising and sales promotion manager.

▸ *RUUD MFG. CO.* — C. V. Coons, chairman of the board; V. J. Heinis, president; A. J. Strain, vice president and director; A. B. Cameron and Kenneth M. Clark, vice presidents; Walter S. Lewis, secretary; W. E. Latta, treasurer.

▸ *THE PHILIP CAREY MFG. CO.* — John W. Humphrey, manufacturing manager for U.S. plants.

▸ *CENTURY ENGINEERING CORP., Heating and Air Conditioning div.* — Michael J. Merfeld, assistant sales manager.

▸ *TOLEDO PIPE THREADING MACHINE CO.* — H. L. Thompson, Jr., Bostwick-Braun Co. president, to board of directors.

▸ *ALLIS-CHALMERS MFG. CO.* — M. M. York, manager of marketing, industrial equipment div.

▸ *FRAM CORP.* — effective at year end: Arthur F. Pettet, president; Frederick A. Knight, executive vice president; Theodore H. Belling, incumbent president, will continue with the firm in an advisory capacity.

WHO'S WHAT

Continued

▸ *AMERICAN STANDARD INDUSTRIAL DIV.* — Graeme B. Supple, product manager air-side air conditioning products; Sheldon D. Johnson, Jr., quality control manager; John B. Koch, director of engineering, Kewanee, Ill., plant; *DETROIT CONTROLS DIV.* — T. C. McKee, manager, sales service; Howard H. Elliott, manager of instrumentation marketing; Robert J. Jones, instrumentation sales manager; J. M. Maitland, technical coordinator.

▸ *CHAS. T. MAIN, INC. Boston consulting engineering firm* — C. M. Flint, Van Court M. Hare, and Will J. Lessard to board of directors.

▸ *PENNSALT CHEMICALS CORP.* — Hugh C. Land and Lee H. Clark, group vice presidents for western and eastern operating divisions, respectively.

▸ *WARREN PUMPS, INC.* — Howard L. Glass, Walter B. Eklund, and Charles F. Dexter, vice presidents for federal-marine sales, operations, industrial sales, respectively.

▸ *PRESSURE ELEMENTS, INC.* — Charles H. Colvin, president; Jack Turk, vice president and chief engineer; Dorothy P. Vogel, secretary and general manager.

▸ *MARATHON ELECTRIC MFG. CORP.* — Robert V. Jones, president.

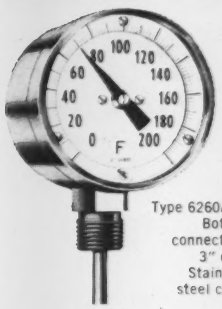
▸ *ALBERT KAHN ASSOCIATED ARCHITECTS & ENGINEERS* — Saul Saulson, vice president and director of mechanical engineering; G. S. Whittaker, vice president and director, and chief of the mechanical div. assumes chief mechanical engineer duties formerly held by Mr. Saulson; Charles Allen, chief, heating engineering; Norton Taylor, assistant chief, ventilating and air conditioning engineering.

▸ *BORG-WARNER CONTROLS DIV., BORG-WARNER CORP.* — Ira E. Weston, chairman of the board; Fred O. Hosterman, president and chief executive officer; Fred T. Miller, vice president and general manager.

Heating and Air Conditioning

TEMPERATURE MEASUREMENT

AMERICAN THERMOMETERS DO THE JOB ACCURATELY



Type 6260AH—Bottom connection. 3" dial. Stainless steel case.

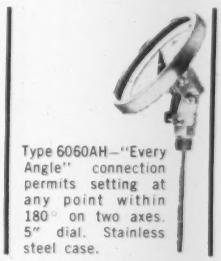
They respond quickly and accurately to all temperature changes, whether mounted on a blower in a basement or on air conditioning equipment on a roof. American Bi-Metal Dial Thermometers combine superior resistance to vibration with the greatest sensitivity in bi-metal actuation. Two other advantages provide extra value:

ANTI-PARALLAX MAXIVISION® DIAL guarantees surest, sharpest, easiest readings. It is a split-level dial constructed with graduations and pointer on the same plane. No perspective effect. No parallax error in reading. Only American Thermometers have this feature.

WEATHERPROOF CONSTRUCTION seals out all atmospheric and application conditions that might cause erosion, corrosion, inaccuracy and shorten service life.

Wherever accurate temperature measurements are essential—whatever the operational temperatures of the heating or air conditioning system — choose American Thermometers. Mounting styles include the "Every Angle" thermometer you can set for face-to-face readings wherever installed. Dial sizes, temperature ranges and stem lengths to meet your needs exactly. *Write for Catalog 100.*

Type 6360AH — Back connection. 3" and 5" dials. Stainless steel case.



Type 6060AH—"Every Angle" connection permits setting at any point within 180° on two axes. 5" dial. Stainless steel case.

Type 6360AH — Back connection. 2" dial permits installation in close quarters without sacrificing readability. Stainless steel case.

MANNING MAXWELL & MOORE

AMERICAN THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

WHO'S WHAT

Continued

▶ *DEARBORN CHEMICAL CO.* — Samuel Kruty, production manager.

▶ *OIL HEAT INSTITUTE OF AMERICA* — president: Fred Heaney, president of Skaggs-Walsh, Inc., Long Island City, N. Y.

▶ *CURTIS MFG. CO.* — James H. Lavely, advertising manager.

▶ *NATIONAL BUREAU OF STANDARDS* — Dr. Alan D. Franklin, chief, mineral products div.

▶ *EATON MFG. CO.* — Paul W. Olson, general manager, Marion Forge div; George R. Frye, general manager, Foundry div.

▶ *FLOMATIC CORP.* — William J. Hastings, sales manager, White Flomatic div.

▶ *YEOMANS BROTHERS CO.* — Spaulding A. Norris, vice president in charge of sales, and member, board of directors.

▶ *BARBER-COLMAN CO.* — E. A. Greenlee, division manager, air distribution, automatic controls, and industrial instruments divs; Peter Van Dae, sales manager, automatic controls div.

▶ *ARTHUR D. LITTLE, INC.* — Lt. Gen. James M. Gavin, (USA Ret.), president; retiring president Raymond Stevens, chairman of the executive committee.

▶ *APRA, INC.* — Percy L. Spencer to board of directors; J. Penn Rutherford, vice president, treasurer, assistant secretary and member of the board.

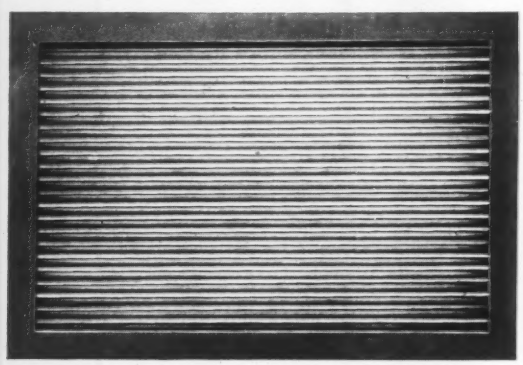
▶ *CRANE CO.* — Joseph W. Rice, director of public relations.

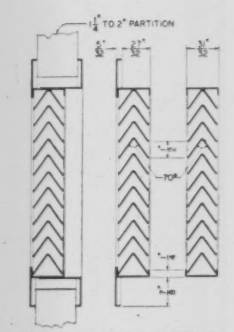
▶ *DEAN HILL CORP.* — Charles W. Schubert, sales office manager.

▶ *CARRIER CORP.* — Henry W. Kuklinski, engineering manager for transportation air conditioning; Dr. John S. Burlew and Dr. Dewey J. Sandell, research and development div, director of research and director of development, respectively.

▶ *CONTROLS CO. OF AMERICA* — George B. Becker, vice president operations and general manager heating and air conditioning division.

New Ruggedness!
A-J Heavy-Duty ALL-STEEL, NO-VISION No. 78 GRILLE





You'll find this new, sturdy, extra-rigid no-vision grille ideal for door or partition installations, and for either return air or exhaust application. It has approximately 50% free area and is completely sight proof. Available in channel frame or flange frame styles, or as a core only. 18-gauge steel inverted "V" louvers are on 1/2" centers. You'll be delighted with the appearance and performance of this new, extra-sturdy A-J Grille!

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A-J MANUFACTURING CO.

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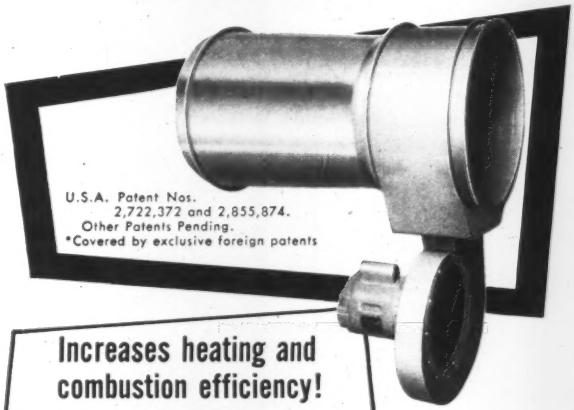
POWER DRAFT UNIT FOR INDUSTRIAL, RESIDENTIAL AND INSTITUTIONAL EXHAUSTING



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2,722,372 and 2,855,874.
Other Patents Pending.
*Covered by exclusive foreign patents

Increases heating and combustion efficiency!

Provides air power for bulk materials handling!

Exhausts corrosive gases and abrasives!

Quickdraft provides industry, commerce, institutions and homebuilders *power draft* engineered for economical and efficient combustion regardless of building or atmospheric conditions. Models suitable for every heating or incinerator application . . . eliminate pulsating or chattering, puffing, smoking and sooting. Reduce building costs, no tall, unsightly stacks required. Quickdraft also provides industry with ¼ inch to 60 inches W.G. static pressure for exhausting corrosive gases, abrasives and paint spray. Heavy-duty, high-pressure models, 6 inches to 30 inches diameter, are available for moving bulk materials or anything that can be moved by air. Because there are no motors, fans or bearings in exhaust line, only Quickdraft avoids costly clogging, corrosion of moving parts or fan failure.

IMPORTANT NOTICE

For withstanding corrosive gases, all Quickdraft units are available in standard acid resisting vitreous enamel, No. 316 Stainless Steel, rigid plastics (P.V.C.) and with plastic and Fiberglas coatings.

N-622-QD

NO MOTORS FANS OR BEARINGS IN EXHAUST LINE

Send for QUICKDRAFT ENGINEERING DATA on your application . . . now.

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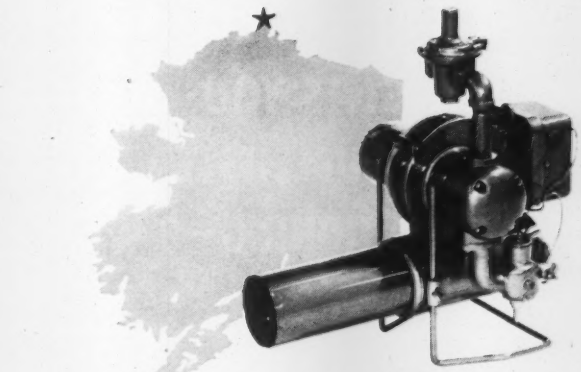
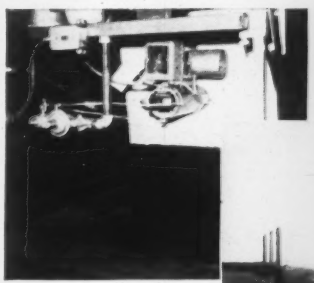


In Barrow, Alaska,
U. S. Weather Bureau Selects

LO-BLAST ECONOMITE

POWER GAS CONVERSION BURNERS



Economite supplies heat for cooking as well as comfort on this converted range in hospital kitchen.

Feeder line crossing Nerrotik lagoon is cable-suspended.

Thirteen Economites and seven Dual Fuel Lo-BLAST Burners burn natural gas with trouble-free dependability to heat personnel housing, offices, warehouses, hospital, school and other buildings in the U.S. Weather Bureau Station, Barrow, Alaska.

Economite adds a bonus of *savings* over and above its dependability—averages 10% lower operating cost. Controlling primary and secondary air perfectly, it functions independently of variable natural drafts—is especially well-suited for down-draft boilers. Combustion is completed in an incandescent firebox, with radiant heat applied to crown sheet and side walls. Other features: soft, quiet-flame... standard controls with positive acting pilot and blower safetys... sturdy, fool-proof design... easy to install because completely assembled and factory-tested on gas.

Lo-BLAST Power Gas Burners are available in 70,000 to 20,000,000 B.T.U. input capacities. Write for literature.

(Use of this product by a U.S. Government Bureau in no way constitutes an endorsement of the product by the Government.)

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1960 N. Clybourn Ave., Chicago 14, Ill.

Oakite Airefiner No. 52 in water

Properly treated water in air conditioning systems goes a long way in prolonging equipment life, improving operating efficiency and keeping systems trouble-free. A small amount of Oakite Airefiner No. 52 added to cooling tower water does all this—and more! A softening and purifying material, Airefiner No. 52:

1. **Checks growth of pipe-blocking, jet-clogging algae and slime**
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SCIENCE

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IN THE TERRITORIES . . .

(Recent sales appointments)

▸ *WORTHINGTON CORP.* — T. J. Driscoll, supervisor, factory wholesale headquarters, Washington, D. C.

▸ *HYNES ELECTRIC HEATING CO.* — Albert J. Ruf, sales engineer for southern New Jersey, eastern Pennsylvania, Maryland, Delaware, and District of Columbia.

▸ *THE PHILIP CAREY MFG. CO.* — William H. Sparker, sales supervisor for Detroit district.

▸ *STEWART-WARNER CORP.* — James L. Brown, district sales manager, heating and air conditioning div., northern Ohio and southern Michigan counties.

▸ *INLAND STEEL PRODUCTS CO.* — Ellsworth Peters, sales representative for Milcor Commodity Products, Minneapolis and St. Paul area.

▸ *HYDROTHERM INC.* — new representatives: Hydronic Heating Distributors, Topeka, Kans.; C. A. Richards Co., Houston, Tex.; Southwest Mechanical Sales, San Antonio, Tex.

▸ *A. O. SMITH CORP., PERMAGLAS DIV.* — new distributors: Arrow-Risco, Inc., Los Angeles; Scranton Plumbing Supply, Scranton, Pa.; J. Lorber Co., Philadelphia; Southern Materials Co., Springfield, Mo.

▸ *DONOVAN ASSOCIATES, Engineering & Sales* — Andrew W. Knight, district representative for eastern Massachusetts, Rhode Island, New Hampshire, and Maine.

▸ *CLEAVER-BROOKS CO.* — new sales agents: Joe Trabue Co., St. Louis; Tate Engineering Inc., Baltimore; and Dixie Boiler & Equipment Co., Nashville, Tenn.

▸ *MAXITROL CO.* — Wesley H. Blaylock, southeastern sales representative.

▸ *ALLIS-CHALMERS MFG. CO.* — John P. Curtis and Patrick A. White, Industries Group representatives for Indianapolis, Ind., and Memphis, Tenn., respectively; Charles F. O'Riordan, manager, North Central region.

▸ *CONNOR ENGINEERING CORP.* — new sales representative: The Archibald Co., Butte, Montana.

PACKLESS FLEXIBLE METAL HOSE AND FITTINGS

PACKLESS PRODUCTS ARE MANUFACTURED FOR MOST EVERY TYPE OF METAL HOSE APPLICATION.
Transfer of gases, liquids, and fine solids where complicated by motion—vibration and noise control—to compensate for misalignment and pipe travel—convey cutting oils and coolants.
IN BRONZE, STAINLESS AND CARBON STEEL—SIZES 1/4" THROUGH 6" I.D. WITH ANY TYPE OR COMBINATION OF FITTINGS.

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REQUEST CATALOG FOR COMPLETE INFORMATION

PACKLESS FLEXLINE CONNECTORS, VIBRATION ABSORBERS, HOSE AND REUSABLE FITTINGS available for immediate shipment from factory stock and warehouses.

PACKLESS METAL HOSE INC.

730-12 S. COLUMBUS AVENUE MT. VERNON, N. Y.

Roberts-Gordon Inshot Gas Burners Feature TELESCOPING MIXER!

NEW

Burner shown with cover removed

● ***Now you can guarantee*** **peak combustion efficiency with minimum installation cost.**

Simplified installation is only *one* of the many advantages of the new telescoping mixer tube offered with the Roberts-Gordon Atmospheric Type 400-R Series and Blower Type 450-P Series Gas Conversion Burners. Now these highly efficient Inshot Burners can be quickly and easily installed because of the adjustability of the mixer tubes. This reduces installation cost. Further customer savings result from increased combustion efficiency. The new Roberts-Gordon telescoping mixer tube makes it easy to position burner port and flame spreader in proper relation to the combustion air stream. The flame conforms to the shape of the combustion chamber for peak heat transfer, fuel economy and heating efficiency.

- **Domestic Burners — Inshot or Upshot Design: 45,000-900,000 BTU/Hr.**
- **Industrial Burners: Up to 20,000,000 BTU/Hr.**
- **Famous Roberts-Gordon "Spreader-Flame" insures utmost heating value for each fuel dollar.**

Roberts-Gordon manufactures a complete line of gas and oil fired warm air furnaces, hot water and steam boilers, conversion burners, unit heaters — and air conditioners.

ROBERTS-GORDON APPLIANCE CORP.

44 Central Avenue • Dept. HP • Buffalo 6, N. Y.

In Canada — Grimsby, Ontario

FOR TOPS IN QUALITY, in Profits, in Selection Be Sure to Sell the Famous Roberts-Gordon Line of Top Quality Heating Equipment! SEND COUPON *NOW* FOR FULL DETAILS!

Yes, I want to cash in on this Hi-Profit Line.
Please send me the latest Roberts-Gordon Catalog.

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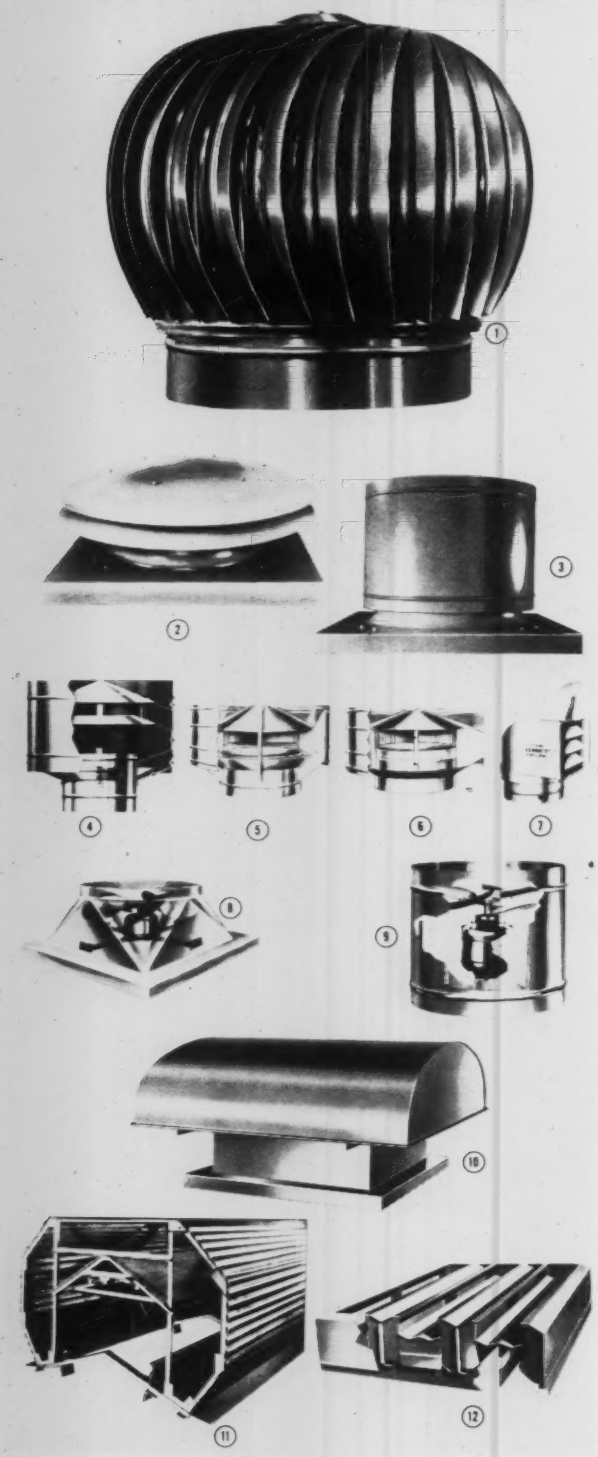

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WESTERN ENGINEERING AND MFG. CO.

P.O. Box 66455
Los Angeles 66, California

Complete Catalog in Sweets, Member Air Moving and Conditioning Assoc., Inc.

WHO'S WHAT

Continued

▸ *SCHIEMENAUER MFG. CO.* — new sales agents: Allied Equipment Co., Cuyahoga Falls, O.; Allen Bullard Co., Little Rock, Ark.; M. A. Disney, Kansas City, Kansas; James Eichorst & Associates, Chicago; Harry M. Harris & Associates, Wichita, Kans.; The Ted King Co., Oklahoma City; Nelson-Crumley, Inc., Richmond, Va.; Shea Equipment Co., San Francisco; Rodgers Engineering Co., Inc., Dallas; and Refrigeration Distributors Corp., Salt Lake City, Utah.

▸ *SAMUEL MOORE & CO.* — G. William Dix, representative for southern California.

▸ *ARVIN INDUSTRIES, INC.* — Charles F. Stannard, district sales manager, Washington, Baltimore, and Philadelphia areas.

▸ *THE FAIRBANKS CO.* — William I. Smith, sales staff member for Philadelphia, eastern Pennsylvania, and southern New Jersey territory.

▸ *BYRON JACKSON PUMPS, INC.* — F. H. Trones, Midwestern regional manager.

▸ *LIMA REGISTER CO.* — C. W. Gupton, district manager for Virginia, North and South Carolina and Georgia territory.

▸ *WESTINGHOUSE ELECTRIC CORP.* — new sales engineers: H. J. Rudisaile, Chicago; Edward A. Zagula, Pittsburgh; E. W. L. Seager, Staunton, Va.; Arthur F. Holland, St. Louis; and Foster Massey, Atlanta, Ga.

▸ *MARLO COIL CO.* — James E. Brennan, sales representative for State of Connecticut.

▸ *CARRIER CORP.* — unit heater regional sales managers appointed: Maurice Merlin, Philadelphia; James P. McLaughlin, Atlanta, Ga.; and Oliver M. Murphy, Cleveland.

▸ *DELAVAN MFG. CO.* — Gilbert H. Tate, sales engineer for Michigan, Illinois, Wisconsin, northern Ohio and northern Indiana.

▸ *WOLVERINE TUBE DIV., CALUMET & HECLA, INC.* — Joseph A. Finnerty, wholesaler sales representative, Detroit area; Robert D. Sebring, western Pennsylvania representative.

▸ *AIR REDUCTION SALES CO.* — J. S. Stevens, district manager, Birmingham, Ala.

▸ *MIDWEST PIPING CO., INC.* — Earl B. Marrs, manager, Tulsa, Okla., sales office.

Robvon's Commercial Backing Rings are designed for quick easy alignment of pipe or tubing and assure precise close tolerance fit-up. Robvon Backing Rings allow complete penetration and fusion of the weld. Robvon Backing Rings radiograph perfect certified welds. The patented nubs automatically set the welding gap for the root-pass. The internal bevel and flat inner land assures non-restricted fluid flow.

ROBVON BACKING RINGS APPROVED FOR WELDING PIPE, VALVES AND FITTING JOINTS

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ROBVON also manufactures machined rings to specification. Write for full information.

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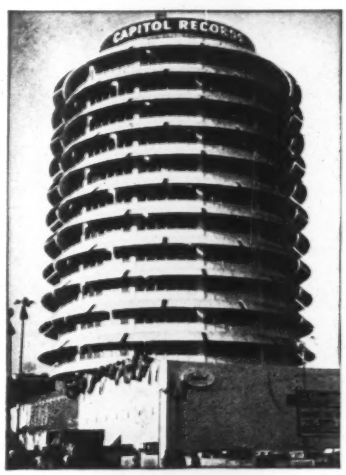

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WELTON, BECKET & ASSOCIATES, ARCHITECTS-ENGINEERS, STATE PLUMBING & HEATING CO., MECHANICAL CONTRACTOR

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MILLER Streamflow CHECK VALVES

Completely Silences your piping system! CENTER-GUIDED, SHOCK PROOF, NOISELESS, ELIMINATES WATER HAMMER. FULL RADIAL FLOW. FACTORY MUTUAL LABORATORIES APPROVED.

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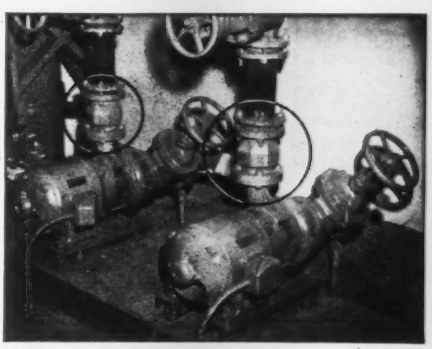
CERTIFIED MINIMUM PRESSURE DROP CURVE AVAILABLE



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MILLER VALVE CO., INC.

Pittsburgh 30, Pa. Plant—1620 Pennsylvania Ave.

FOR SIMPLIFIED INSTALLATION

AND COMFORTABLE ROOM HEAT

USE SHAW Panel-Vectors

Shaw Panel-Vectors are of rigid, fully-integrated construction, delivered ready to install. There are no dampers or separate housings to fit and hang. Choice of same end or opposite end tapping offers opportunities for important piping simplification and economies.

Panel-Vectors distribute a *low-temperature*, unvarying combination of radiant and convected heat that only Nature—at her best—can rival. Stratification, and areas of extreme heat or chill are eliminated . . . room occupants are not only warm, they are *comfortably* warm.

Shaw Panel-Vectors use hot water or steam up to 150 psi. They are available in wall-hung (panel) or baseboard models, each a space-saving 3" deep. There is a full range of sizes to meet any room-heat distribution requirement.

Find out today about Shaw Panel-Vectors—the radiators that give you simplified installation, give the owner *comfortable* heat. Write for free literature on wall-hung and baseboard models.

SHAW PERKINS MFG. CO.

Properly Designed Room Heat Distribution Equipment

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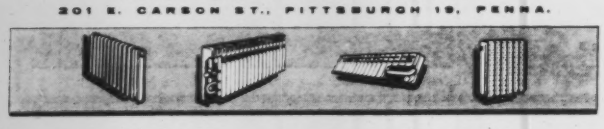

WHO'S WHAT

Continued

▸ *FLEXIBLE TUBING CORP.* — Roger F. Vaughn regional sales engineer, north central states.

▸ *A. M. BYERS CO.* — new PVC plastic engineering representative: Frank P. Cyrill, Jr., Boston and New York territories; W. E. Weber, Pacific Coast div. manager.

▸ *WESTERN ENGINEERING & MFG. CO.* — new factory representatives: R. E. Gardner Co., Nashville, Tenn.; Keatts Thermal Equipment Co., Columbus, O.; McGee-Feher Co., Pittsburgh; W. C. Murphy and Associates, New Orleans; Rodman Engineering Co., Kenmore, N. Y.

▸ *TUBE TURNS DIV., CHEMETRON CORP.* — Jack D. Tolliver, U. S. field sales manager.

▸ *CENTURY ENGINEERING CORP.* — George G. Wolfe Sales Associates, representatives for heating and air conditioning div., New York, New Jersey, and Pennsylvania.

▸ *THE BRUNDAGE CO.* — Don Dillon, field representative, Midwest territory; Tom Tipton, order department manager.

▸ *GRABLER MFG. CO.* — John S. Evans, Minneapolis branch manager.

▸ *BROWN FINTUBE CO.* — Horblit & Co., Albuquerque, N. M., sales representative.

▸ *HOOKER CHEMICAL CORP., DUREZ PLASTICS DIV.* — Robert M. Stroman, Buffalo district sales manager; Edward F. Borro, Jr., assistant product manager, molding compounds.

▸ *JOSEPH T. RYERSON & SON, INC.* — William P. Loenrer, district sales manager, Chicago; G. Philip Later, manager of alloy and stainless steel sales.

▸ *CHRYSLER CORP., AIRTEMP DIV.* — new distributors appointed: W. R. Millar Co., Minneapolis; Walloch Wholesale, Inc., Little Rock, Ark.; Air Conditioning Inc., Salt Lake City; and Refrigerative Supply, Inc., Portland, Ore.

▸ *GENERAL ELECTRIC CO.* — O. M. Raith, sales specialist, air conditioning, Bloomington, Ill.

▸ *WELBILT AIR CONDITIONING AND HEATING CORP.* — Excel Refrigeration Supplies, Inc., Brooklyn, franchised representative; Milton Levine, district sales manager, metropolitan New York and Westchester County.

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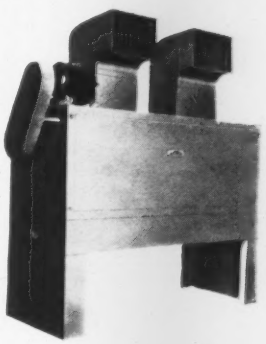


Series 73 Heating, Ventilating Unit

RUGGED CONSTRUCTION

Built for Efficient Performance, Long Life and Trouble-Free Operation

WRITE FOR PRODUCT BULLETIN 73

United States Air Conditioning Corporation
Delaware, Ohio

MEETINGS & CONVENTIONS

MAY 9-12—*Instrument Society of America. 2nd Instrument-Automation Conference and Exhibit.* Civic Auditorium and Brooks Hall. San Francisco. Calif. Information: Instrument Society of America. 313 Sixth Ave., Pittsburgh 22. Pa.

MAY 9-12—*Mechanical Contractors Association of America. Inc., Annual Convention.* Waldorf-Astoria Hotel. New York City. Information: Mechanical Contractors Association of America. Inc., 15 Rockefeller Plaza. New York 20. N. Y.

MAY 11-11—*The Fluid Controls Institute. Inc.,* Spring meeting. The Greenbriar. White Sulphur Springs. W. Va. Information: E. R. Rath. Executive Secretary. P.O. Box 667. Pompano Beach. Fla.

MAY 22-26—*Air Pollution Control Association. 53rd annual meeting.* Netherland-Hilton Hotel. Cincinnati. O. Information: APCA Annual Meeting. 2400 Beekman St., Cincinnati 11. O.

JUNE 2-3 — *Third Annual Consulting Engineering Management Institute.* University of Wisconsin. Madison. (*You'll Want To Know. page* 41) Information: Robert L. Loetscher. Engineering Institutes. University Extension Div., 3030 Stadium. The University of Wisconsin. Madison 6. Wis.

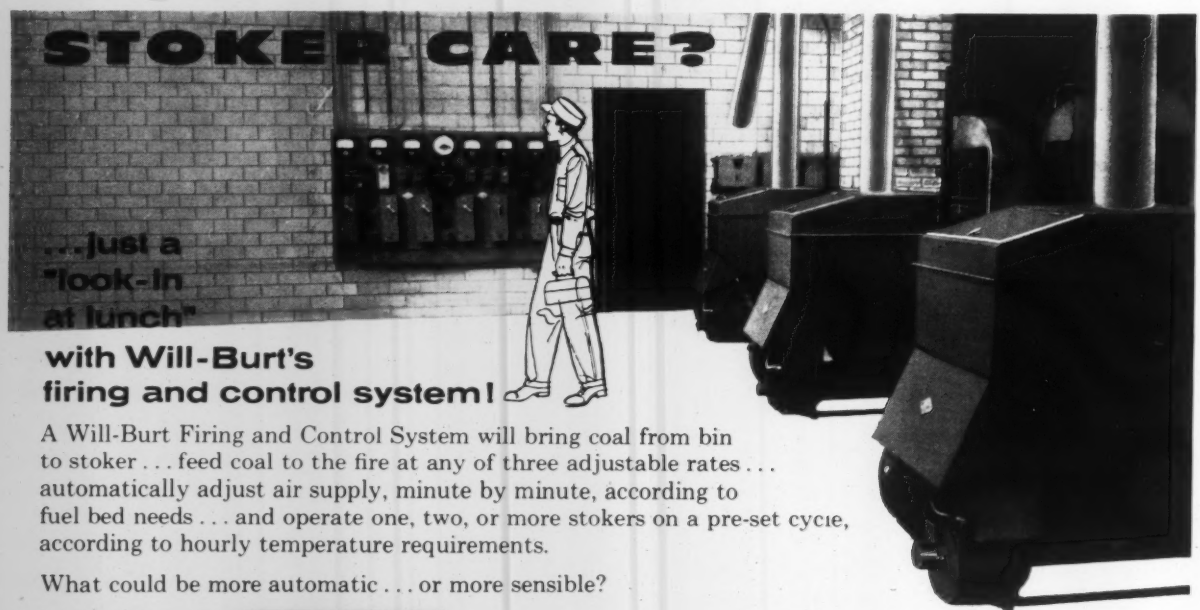
JUNE 5-9—*9th National Plastics Exposition and SPI National Conference.* sponsored by the Society of Plastics Industry. Inc. Exposition: Coliseum. New York City. Conference: Commodore Hotel. New York City. Information: The Society of Plastics Industry. Inc., 250 Park Ave., New York 17.

JUNE 6-9—*National District Heating Association 51st annual meeting.* Grove Park Inn. Asheville. N.C. Information: National District Heating Association. 827 N. Euclid Ave., Pittsburgh 6. Pa.

JUNE 13-15—*American Society of Heating. Refrigerating and Air-Conditioning Engineers. Inc., annual meeting.* Vancouver. B.C., Canada. Information: American Society of Heating. Refrigerating and Air-Conditioning Engineers. 62 Worth St., New York 13. N. Y.

JUNE 14-19—*Electrical Precipitation Seminar.* The Pennsylvania State University. Information: Ralph E. Armington. Associate Chairman of Electrical Engineering. The Pennsylvania State University. University Park. Pa.

JUNE 20-21—*American Society for Engineering Education. 68th annual meeting.* Purdue University. Lafayette. Ind.



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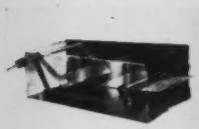
A Will-Burt Firing and Control System will bring coal from bin to stoker . . . feed coal to the fire at any of three adjustable rates . . . automatically adjust air supply, minute by minute, according to fuel bed needs . . . and operate one, two, or more stokers on a pre-set cycle, according to hourly temperature requirements.

What could be more automatic . . . or more sensible?



W-B Automatic self-adjusting Air Control . . . part of every W-B Stoker.

W-B Coal Conveyor . . . power-reversing to clear obstructions . . . operates at any angle.

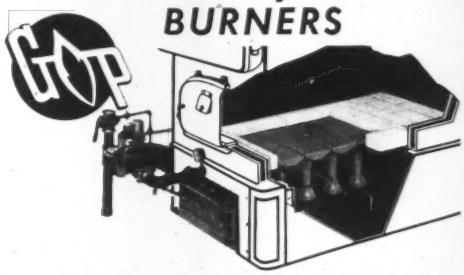
WILL-BURT

Take our word for it, it's economical. Write direct — or ask your Will-Burt Stoker Specialist for bulletins and help on selection and installation.

WILL-BURT STOKERS • Orrville, Ohio

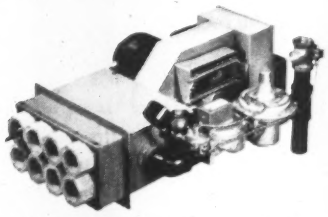
*"Planned Performance"**

BURNERS



For heating and power boilers. 23 sizes listed in Catalog No. A-10.

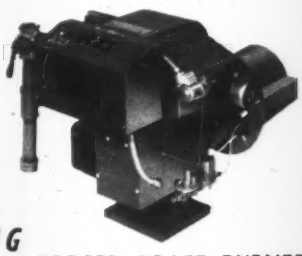
BLUE LINE UPSHOT ATMOSPHERIC GAS BURNER



Fully automatic, packaged assembly. Sizes listed to 28 million BTU/HR in Catalog C-10

TURBO-FIRE POWER TYPE GAS BURNER

MODEL R
Capacities up to
2¼ million BTU/HR
Catalog E-61

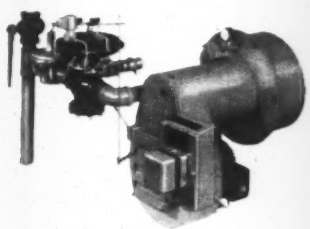


TURBO-RING

FORCED DRAFT BURNERS

Gas, oil, or combination Gas-Oil burner. No stack required on boilers equipped for pressure firing.

MODEL FGR
Capacities 1 to 9
million BTU/HR
Catalog E-51



* PLANNED — Factory assembled, pre-wired for "Bolt-in" installation.

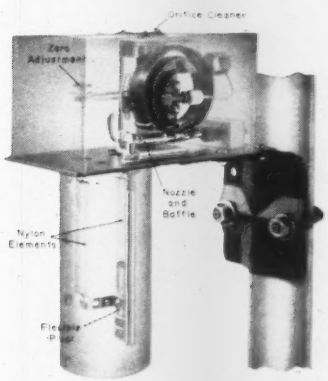
* PERFORMANCE — Custom matched to individual boilers for quiet, efficient operation.

Gordon & Piatt also manufacturer of a complete line of domestic conversion burners plus large dual-fuel units. Write for literature and complete information.

Gordon & Piatt
P. O. Box 914
Winfield, Kansas

New FROM *Taylor*

No. 207T RELATIVE HUMIDITY TRANSMITTER



Phantom View of Room Model

Simple. A non-indicating, pneumatic, motion-balance transmitter, the No. 207T produces an air output pressure proportional to the relative humidity around the sensing elements, permitting a direct reading in the receiving instrument.

Easy to adjust. Zero setting can be checked by comparing the output with relative humidity determined by a wet and dry bulb hygrometer. Adjustment is by means of a knurled nut on the Bourdon spring take-off arm.

Easy to maintain. Nylon elements, nozzle-baffle system and Bourdon spring element are easily accessible; stainless steel nozzle simply removed for cleaning; finger-tight tubing connections.

Write for

Bulletin 98338

Taylor Instrument Companies
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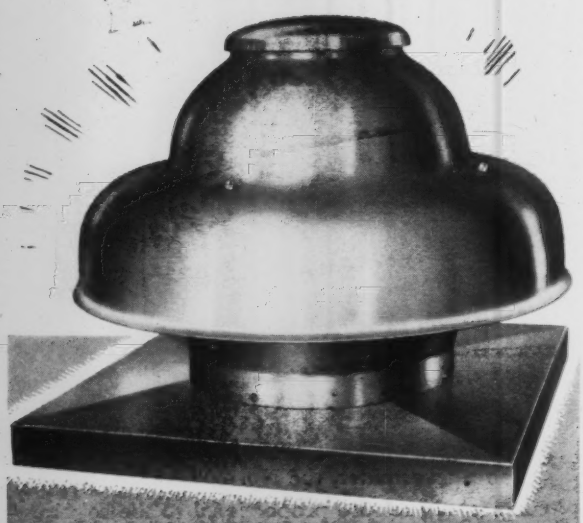
Aladdin
AIR HANDLING EQUIPMENT

Type "S" Centrifugal
ROOF VENTILATORS



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- ATTRACTIVE DESIGN
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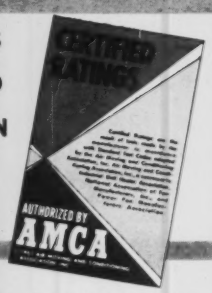
- QUIET OPERATION



ALADDIN Type "S" Roof Ventilators feature an attractive Spun Aluminum Housing of low contour. Designed especially for those installations which require a small powered exhaust unit. The Type "S" Roof Ventilator is ideally suited for schools, hospitals and similar type buildings.

Seldom requiring maintenance, these units are furnished with unusually quiet, fan cooled motors with outstanding lubricating systems, assuring long, continuous service under severe conditions of dust and dirt.

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MEETINGS & CONVENTIONS

Continued

JULY 25-29—*13th International Congress on Occupational Health*. Waldorf-Astoria Hotel, New York. Information: Dr. Leo Wade, 15 W. 51 St., New York, N.Y.

SEPT. 7-9—*Joint Automatic Control Conference*. Massachusetts Institute of Technology, Cambridge, Mass.

SEPT. 14-17—*Second Annual Southeastern Maintenance and Engineering Show*. Sponsored by North Carolina chapters, American Institute of Plant Engineers, American Welding Society, and Maintenance Council of North Carolina Motor Carriers Assoc. State Fair Arena, Raleigh, N.C. Information: John Harden Associates, P.O. Box 3173, Greensboro, N.C.

OCT 12-15—*Cast Bronze Bearing Institute and Non-Ferrous Founders' Society annual meetings*. Grove Park Inn, Asheville, N.C. Information: Non-Ferrous Founders' Society, 1604 Chicago Ave., Evanston, Ill.

OCT 17-21—*48th Annual National Safety Congress*. Industrial safety sessions, Conrad Hilton, Pick-Congress, Sheraton Towers, Morrison, and La Salle hotels, Chicago. Information: R. L. Forney, secretary, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

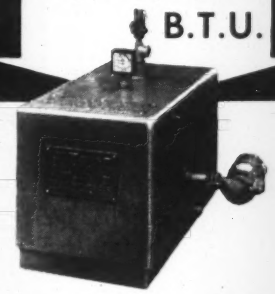
NOV. 28-*DEC.* 2—*24th National Exposition of Power and Mechanical Engineering*. Under auspices of the American Society of Mechanical Engineers. New York Coliseum. Information: International Exposition Co., Inc., 480 Lexington Ave., New York 17.

NEW BOOKS & REPORTS...

The Promise of Economic Growth—55 pp. Discussion of U.S. economic growth rate. Economic Research Dept., Chamber of Commerce of the United States, Washington 6, D.C. $1.00

Connecting Induction Motors, 4th ed. (revised)—125 pp. by A. M. Dudley and S. F. Henderson. McGraw-Hill Book Co., Inc., New York. $13.50.

ELECTRIC HOT WATER HEAT TO 2,000,000 B.T.U.



- 40,948 B.T.U. to 2,000,000 B.T.U. Output.
- All units meet the requirements of the ASME Boiler and Pressure Vessel Code.

PRECISION Electric HOT WATER HEATING BOILER

- **Complete unit ready for installation** with circulating hot water system and water chiller for year-round air-conditioning.
- **Conversion easily accomplished** where other type fuels now used. Suited for homes, churches, apartments, hotels, motels, hospitals, commercial buildings, swimming pools, snow melting and domestic hot water. Temperature Range 60 to 250 degrees.
- **Every unit tested and inspected.**

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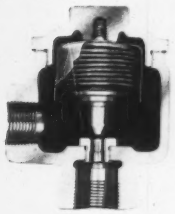
FOR MAXIMUM EFFICIENCY CHOOSE FROM THIS LINE OF RIGGIO THERMOSTATIC STEAM TRAPS

For pressures from Vacuum to 200 lbs. Bronze Construction ½", ¾", 1"



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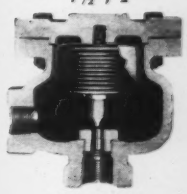
Simple

Rugged

Versatile

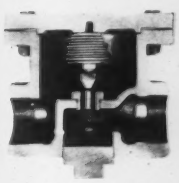
Tight Shut-off

For pressures from Vacuum to 250 lbs. Semi-steel Construction ½", ¾", 1", 1¼", 1½", 2"



TYPE C-250 Freeze-Proof

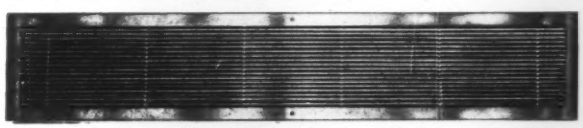
TYPE Y-200



TYPE B-250

For additional information contact

FRANK D. RIGGIO CO., INC.
State Highway 17, Rutherford, New Jersey
Phone Webster 9-8450



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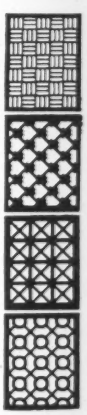
When you need grilles that retain their original attractive appearance indefinitely — against any probable amount of rough treatment — you'll be starting right by sending for our latest bulletins. They show designs developed during nearly half a century of successful experience.



Bulletin 41 illustrates and describes Diamond Architectural Grilles; stamped from any commercial metal in a wide variety of artistic designs; in any desired thickness up to one-fourth inch.

Bulletin 43 illustrates and describes Diamond Fabricated Grilles; heavy-duty bar-type grilles designed and built to give the best possible combination of enduring strength and high open area.

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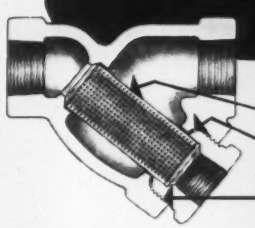

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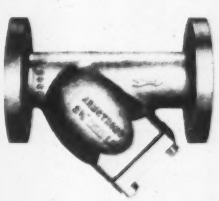

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CHROME MOLY WC6 STRAINERS, 900 lbs., at 900° F
Screwed or Socket Weld. Connections—½"-2"

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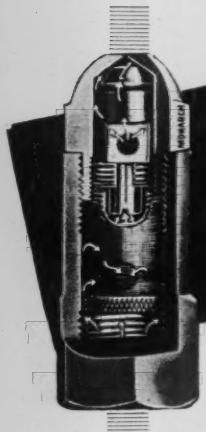

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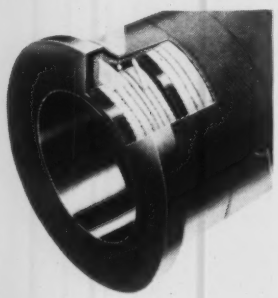

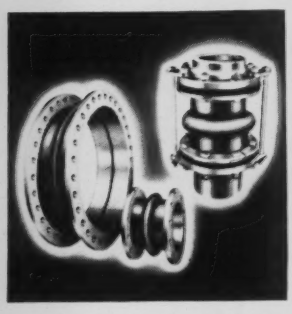

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RM1038

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NEW BOOKS & REPORTS

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Foundry Radiation Protection Manual—American Foundrymen's Society, Golf & Wolf Rds., Des Plaines, Ill. $9.00, or $6.00 to members.

Special Sources of Information on Isotopes—51 pp. Office of Isotopes Development, U.S. Atomic Energy Commission, Washington 25, D.C. No charge.

Proper Gas Venting. Theory of venting and principles of double wall gas vent operation discussed in first of a series of bulletins available from the Gas Vent Institute, 332 S. Michigan Ave., Chicago 4, Ill. No charge.

The U. S. Industrial Outlook for 1960. 312 *pp. Review* of 89 selected industries. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $1.50

Radioisotopes in Science and Industry. Summary of AEC's isotopes development program. Superintendent of Documents, Government Printing Office, Washington 25, D.C. $1.25

Centrifugal Pump Application Manual. 227 pp. Buffalo Pumps Div., Buffalo Forge Co., Dept. 25, 490 Broadway, Buffalo, N.Y. $5.00

Standards of the Tubular Exchanger Manufacturers' Association. 144 pp. Tubular Exchangers Manufacturers' Association, 53 Park Place, New York 7, N.Y. $6.00

ARI Standard for Sealed Refrigerant Compressors and Condensing Units, 20 hp and Smaller, #515-60. Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C. 25 cents.

Labor Reform Law, 1959. *The Landrum-Griffin Act*. 251 pp. Labor Relations and Legal Dept., Chamber of Commerce of the United States, Washington 6, D.C. $5.00

1959 *Supplements to Book of ASTM Standards*. Separate parts cover 10 sections of book. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $4 per part in paper cover, $40 per set.

1960 *Guide to NEMA Standards*. 18 pp. National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y. No charge.

U.S.S.R. Literature on Air Pollution and Related Occupational Diseases, Vol. I. Condensed and translated by B. S. Levine, Ph.D. Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. $3.50. A list of other Soviet technical articles and books currently available can be obtained by request for "OTS 60-86" from the above source.

Proceedings of the 1959 *Symposium on Low-Temperature Nuclear Process Heat (TID-7580)*. Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. 75 cents.

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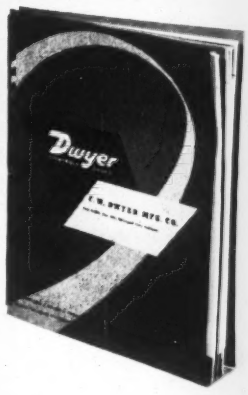

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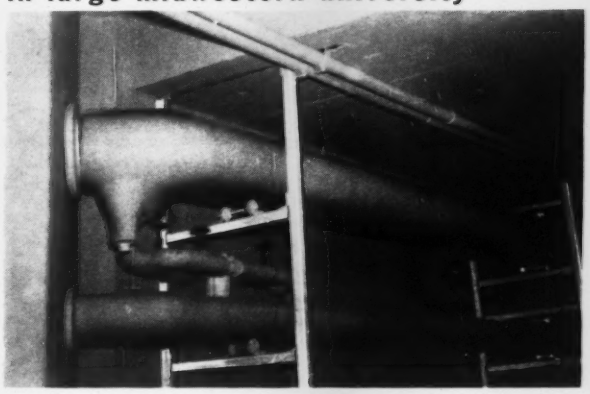

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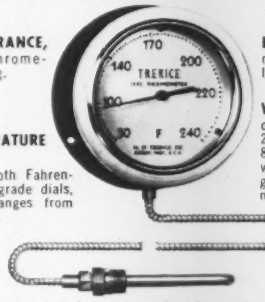
NEAT APPEARANCE, distinctive chrome-plated dial ring.

WIDE TEMPERATURE RANGES, available in both Fahrenheit and Centigrade dials, temperature ranges from -100° to 1000° F.



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WIDE VARIETY, dial available in 2", 2½", 3½", 4½", 6", 8½" and 12" diameters with mercury, vapor, gas, solid liquid or bi-metal actuation.

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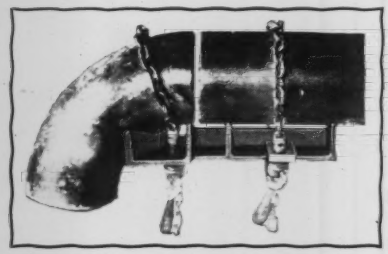
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Obituaries

Ephraim H. Brown

EPHRAIM H. BROWN, secretary and director of the Ohio Brass Co., died March 23, after suffering a heart attack in Washington, D.C.

Mr. Brown's entire business career was spent at Ohio Brass, which he joined in 1924. He was elected to the board of directors in 1947 and became secretary of the company two years later. He was a director and past president of the Ohio Manufacturers Association, a member of the policy committees of the National Association of Manufacturers and the United States Chamber of Commerce.

Clyde E. Ploeger

CLYDE E. PLOEGER, 58, director of engineering at Bendix-Westinghouse Automotive Air Brake Co., Evansville Div., passed away on April 6 in Buenos Aires, Argentina.

Prior to joining Bendix-Westinghouse in 1956, Mr. Ploeger was chief engineer of the commercial refrigeration division of Servel, Inc. He was a member of the American Society of Heating, Refrigerating, and Air Conditioning Engineers and the American Institute of Electrical Engineers.

J. E. Silar

J. E. SILAR, 45, assistant secretary and assistant treasurer of the York Division, Borg-Warner Corp., passed away on March 25 at his home in York, Pa.

Mr. Silar joined the company in 1931 and had served as general insurance manager and assistant treasurer before election to his positions last held.

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Manufacturers' Agents...

We are occasionally asked by our manufacturer advertisers to suggest the names of manufacturers' agents in various sections of the country whom they can contact in regard to representation of their industrial and large building heating, piping and air conditioning products.

If you would like your name listed on our records for inquiries we may receive on your territory, we invite you to write us. There is no charge in connection with this service.

HEATING, PIPING & AIR CONDITIONING
6 North Michigan Avenue, Chicago 2, Illinois

. . . find what you need quickly and economically through . . .

CLASSIFIED ADVERTISING

Rates for classified advertising are 15 cents for each word including heading and address. One inch $7.00. Count nine words for keyed address. Minimum $2.50 for each insertion. Cash must accompany order. Closing date 10th of month preceding issue.

✔ SITUATIONS OPEN

Draftsmen — must have heavy experience in detailing sheet metal duct layout for all types of commercial and industrial work. Steady employment $4.50 per hour, 35 hour week, double time for overtime, welfare, pension, vacation benefits. Box HP208, 125 West 41st St., New York, New York.

FAN SALESMAN. Experienced for sales manager's position for Pittsburgh office. Salary plus bonus. Send complete resume. Address Key 1464A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Illinois.

MECHANICAL ENGINEER. Excellent opportunity at Project Engineer level for BSME with minimum 10 years experience, preferably in heating, ventilating and air conditioning. Extremely wide variety of work including client contact with established Midwest consulting firm. Good starting salary, advancement, and vacation program. Moving expenses paid. Address Key 1445A, Heating, Piping & Air Conditioning, 6 N. Michigan Avenue, Chicago 2, Ill.

SALES ENGINEER — Challenging opportunity with leading manufacturer of hot water heating equipment, pumps and accessories, for an experienced salesman calling on plumbing and heating wholesalers, contractors, and mechanical engineers. College degree or equivalent experience required. Willing to relocate. Send resume and salary requirements to Key 1459A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

MECHANICAL ENGINEERS

With 3 or more years experience in mechanical design for buildings, including heating, air conditioning, plumbing, etc. Permanent employment with well-established midwestern consulting engineering firm. Write Key 1423A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill., giving personal resume and required salary.

✔ FOR SALE

MECHANICAL ESTIMATOR'S GUIDE, 1960, new well organized estimator, solid, up to date pricing labor and material any size air conditioning project — piping, chillers, insulation, towers, charcoal filters, blowers, etc. Eliminates waste hours, for high caliber owners and engineers, a profit standard, plastic bound. $6.00. Write Technical Guide Publications, Dept. P., 224 N. E. 59th Street, Miami, Florida.

✔ AGENTS WANTED

Manufacturers agents wanted by leading manufacturer of Pipe Alignment Guides. Prefer agents handling Expansion Joints or similar pipe specialties. Address Key 1467A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

WANTED

Manufacturers' Representatives & Distributors to sell our line of insulation coatings and U/L rated fire re-tardants. F-X 10 Lagging adhesive, FIRE LAG (meets military spec. MIL-C-3004), F-X 61 MINERAL PLASTIC INSULATION, F-X 36 Fire retardant paint. EPOXY Adhesives & Compounds. Write to BUILDERS RESEARCH & CHEMICAL COMPANY, 5631 Raritan, Denver 21, Colo.

MANUFACTURER'S AGENTS

An established manufacturer with 25 years experience producing ventilating equipment is looking for manufacturer's agents in many sections of the country to sell their new line of industrial fans.

The products include axial flow and tubeaxial fans, both direct and belt driven, and power roof ventilators. Please reply Key 1361A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

Manufacturer of four complete lines of commercial and industrial forced air heating equipment, ranging from 185,000 to 2,000,000 B.T.U. output, has openings in many sections of the country for active representatives with allied lines. See page 219 for the new addition to our line. Mammoth Furnace Company, 6425 Cambridge St., Minneapolis 16, Minnesota.

Manufacturers' Representative contacting consulting engineers, mechanical contractors, architects, and heating and air conditioning engineers in large commercial and industrial installations, and distributors to represent established manufacturer of air filters. Products represent advanced solutions to filtration problems and offer repeat volume opportunities. See our display ad elsewhere in this issue. Several good territories now open. Only representatives well established and representing quality products considered. Microtron Corporation, P. O. Box 2092, Charlotte 1, North Carolina.

✔ DECALS

NAME DECALS & TRUCK SIGNS — Save 50% — Made to order. Write: ACADEMY DECALS, 3324 Altamount St., Cleveland 18, Ohio.

✔ NAME PLATES

IDENTIFICATION NAME PLATES for controls and panels — precision engraved on bakelite or black anodized alum. — any titles — quick service by mail on small or large jobs — send for sample and prices. ATLANTIC ENGRAVERS, Coldbrook Road, Wilmington, Vermont.

NAME PLATES

Machine engraved on black surface bakelite with white lettering or on black anodized alum — any titles — for controls, panels, consoles, etc. — Quick service by mail — send for sample and prices. G. F. BUNNELL CO., 645 Cypress Road, Vero Beach, Florida.

✔ LINES WANTED

LINES NEEDED MECHANICAL ENGINEER ESTABLISHING AGENCY — Seven years experience in applied air conditioning, gas fired unit & duct heaters, electric & pneumatic controls and roof ventilators. Personally acquainted with many consulting engineers and mechanical contractors in Georgia. Agency experience and success in quoting and closing negotiated and contract jobs. Resident of Atlanta for eight years. Will only consider quality lines on an exclusive statewide basis. Reply in absolute confidence, Key 1466A, Heating, Piping & Air Conditioning, 6 N. Michigan Avenue, Chicago 2, Ill.

NEED CHICAGO SALES?

Well established (22 years) manufacturers' representative expanding office seeks line complementary to quality industrial fan line sold primarily to Chicago area industry and contractor trade. Contact F. A. McCullough & Co., 5875 N. Lincoln Ave., Chicago 45, Ill.

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The basic Power Unit...

Here's the single basic tool that gives you a new degree of on-the-job fastening versatility. Only *one* basic unit to buy—the Remington Model 455A—for all your fastening applications. Just choose the instantly interchangeable fastening attachment you need to do the job!

Plus choice of 4 fastening attachments...

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K-2 1/4" Light-Duty Attachment uses 22 cal. Power Loads. Handles 80% of your fastening jobs.

K-3 3/8" Medium-Duty Attachment drives heavy-duty studs with inexpensive 22 cal. Power Loads.

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offers greatest single-tool fastening versatility!

The Remington Stud Driver offers these exclusive features:

- Four fastening attachments for light, medium, heavy-duty work, including the special Captive Stud Attachment for extra-safe fastening. No other single tool can cover such a variety of applications.
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- Positive one or two-hand operation at operator's option . . . no buttons or release to hold while fastening.
- Greater variety of applications made possible with instantly interchangeable guards. These 4" square, hollow "safety guards" fit snugly over work, trap spall and dust. More than 40 types are available.

Send coupon for free booklet about the Remington Stud Driver—your best buy in powder-actuated fastening tools!

Remington

DUPONT

Remington Arms Company, Inc., Bridgeport 2, Conn.
IN CANADA: Remington Arms of Canada Limited, 36 Queen Elizabeth Blvd., Toronto 18, Ont.

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Remington Arms Company, Inc., Bridgeport 2, Conn. HPA-5
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☐ Stud Drivers ☐ Air Tools ☐ Chain Saws
☐ Concrete Vibrators ☐ Flexible Shaft Machines

*Name*_____ *Position*_____
*Company*_____
*Address*_____
*City*_____ *Zone*____ *State*____

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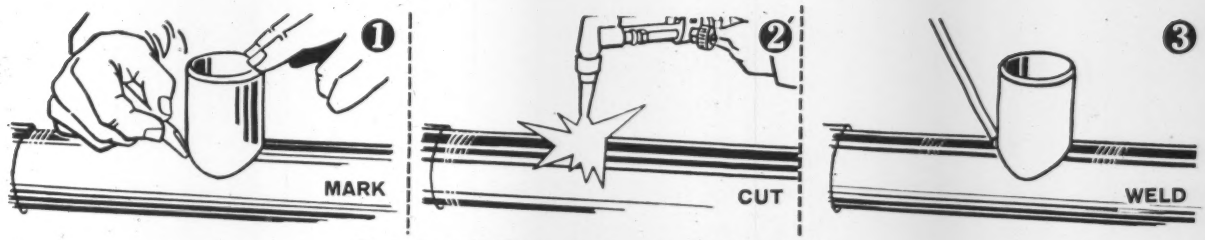
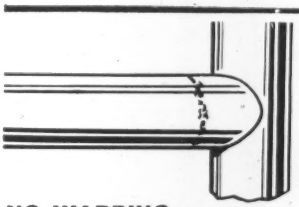
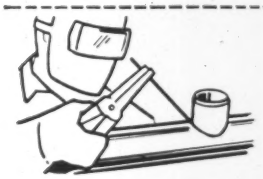


EASIEST TO INSTALL



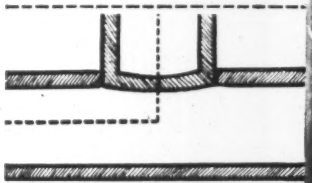
NO WARPING

There is uniform application of heat in all weld layers. This means less chance of warping even in larger sizes.



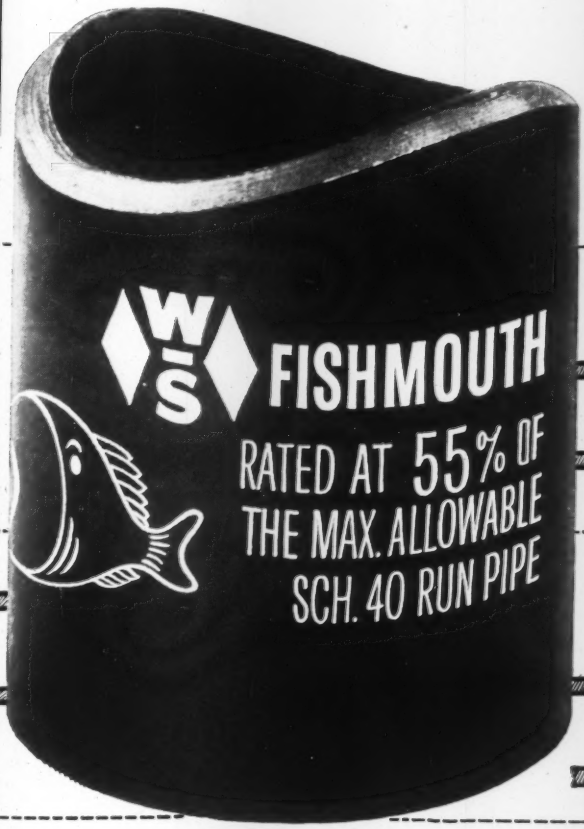
EASIEST TO WELD

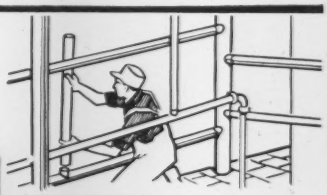
The Fishmouth's machine finished contour makes full penetration welds possible—even with novice welders.



INSURES SQUARE CONNECTIONS

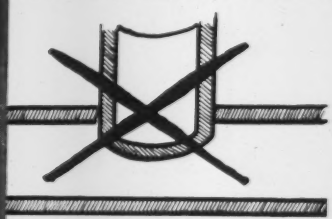
Fishmouth always sits at 90° angle because of the perfect machine contour. Only aligning needed is in one direction.



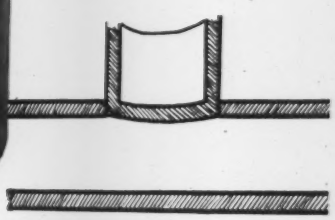


BEST FOR CLOSE QUARTERS

Perfect for any tight corner or other awkward spot. No need for lengthy, involved alignment.



IMPROVES FLOW CONDITIONS



BRANCH CONNECTION

...at lowest cost to you!

Actually a pipe-in-hole connection is cheaper, but it produces large pressure drops, restricted flow and frequent insecure welds. With W-S FISHMOUTH, you get a fully machined and perfectly shaped fitting for strongly welded, leak-proof joints.

Made from Schedule 40 pipe, the W-S FISHMOUTH is available in 2″ to 12″ sizes, butt weld ends. Write today for complete information, prices and names of distributors to Forge & Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.

FORGE AND FITTINGS DIVISION PORTER ***H. K. PORTER COMPANY, INC.***

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

A.O. Smith has the horses!

800 to 1 hp favorites for quiet operation, low maintenance and long-life service . . .

From the case of the A. O. Smith Motor Man — a complete stable of integrals that include single-phase models (1-5 hp) or polyphase (1-800 hp). Also a team of fractional-hp motors. All are sure bets to give top performance over the long, long haul.

And there's an A. O. Smith Motor Man near you — champing at the bit to give you 24-hour action on all parts and service orders.

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Through research . . . a better way

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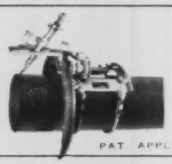
CORPORATION
ELECTRIC MOTORS
Tipp City, Ohio
A.O. SMITH INTERNATIONAL, S.A.
Milwaukee 1, Wisconsin, U.S.A.

PRODUCTS FOR PROFITABLE PIPE CUTTING AND BEVELING

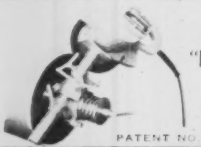
STD. MACHINES



PAT. APPLIED FOR

FAST, accurate cutting and beveling of all sizes of pipe from 1½" - 36". Simple operation . . . operator can master machine in a matter of minutes.

"BEVEL-LAND" GRINDER



PATENT NO. 2,869,293

No more time consuming handwork. "BEVEL LAND" smooths pipe cuts and accurately places the lands on bevels in a matter of seconds.

OUT-OF-ROUND

Insures even, accurate cuts of irregular pipe. Roller rides pipe surface . . . makes cutting easy, simple. Fits all H&M Machines.

PATENT NO. 2,845,115

SHAPE CUTTER

Accurately cuts saddles, tees, els and other irregular shapes. Lightweight, extremely portable . . . fits all H&M Machines.

PATENT APPLIED FOR

WRITE FOR CATALOG SHEETS AND PRICE LISTS ON THE COMPLETE H&M LINE.

H&M
TM Reg.

PIPE BEVELING MACHINE COMPANY
311 E. Third St. DI 3-0241
TULSA, OKLAHOMA

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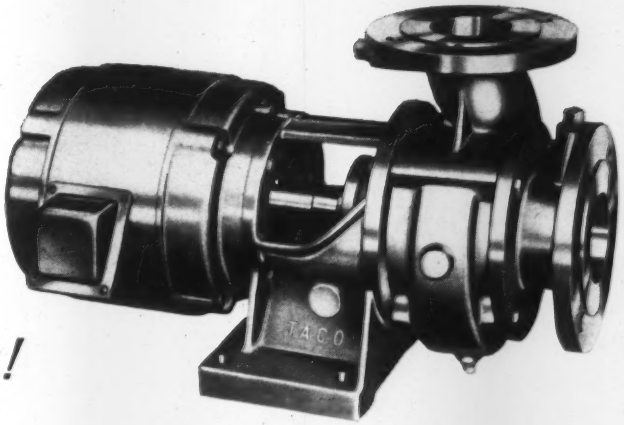
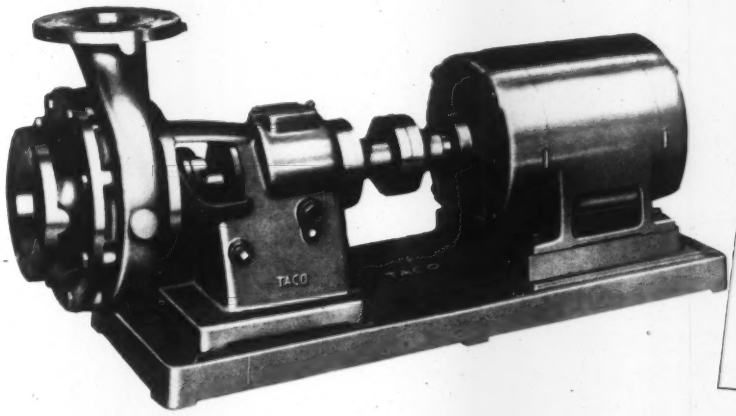
Now...
the pump line
with total
range efficiency!





Standardized Line... Special Capabilities

- Highly Standardized Component Parts
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- Mechanical Seals or Stuffing Boxes
- Ball or Sleeve Bearing Frame
- Stainless Steel Shaft Sleeves
- Casings Adaptable to Horizontal Discharge
- Available with EXTRA Quiet Motors

TACO "LP" *Single Stage Centrifugal Pumps*

High overall efficiency throughout its entire usable range is a basic characteristic of every TACO "LP" Series Pump. And the *complete selection* of sizes available gives *complete* coverage . . . permits each pump to be precisely tailored to the installation. As a result, you're *certain* of better performance when you specify an "LP" . . . and can often save on motor cost and power consumption.

Many of the outstanding advantages of the "LP" line are the result of their "preferred number" design (ASA Standard No. Z 17.1). Using it, TACO was the first manufacturer with a line of pumps uniformly designed and engineered to provide the broadest possible performance field with the minimum number of pumps. It gives consulting engineers and contractors pump versatility and quality that they can specify with confidence.

TACO also manufactures a complete line of smaller pumps and circulators for air conditioning and heating installations. Get complete specifications in time for your next installation.

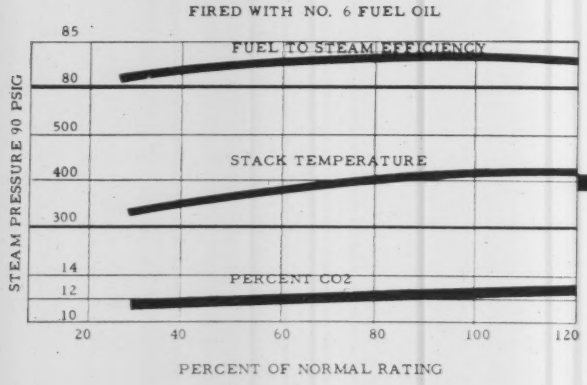
Write TACO HEATERS, INCORPORATED, 1160 Cranston Street, Cranston 9, Rhode Island.

Taco

SERVING THE HYDRONIC INDUSTRY SINCE 1920

Continental

2-PASS DESIGN...



2-PASS AUTOMATIC BOILER GUARANTEES 80% EFFICIENCY ON *EVERY* FUEL

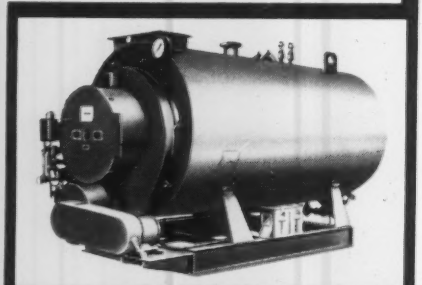
HIGH EFFICIENCY over its entire life is assured by Continental's 2-Pass construction. Continental boilers guarantee 80% minimum efficiency on every oil, gas or combination use of fuel.

SUSTAINED HIGH EFFICIENCY—The simplified Continental 2-Pass design assures brand-new performance for the life of the boiler. High CO_2 is produced, and low stack temperature is guaranteed not to exceed 125°F. above boiler water temperature.

15 to 600 hp Steam Boilers — to 250 psi

Hot Water and HTW Boilers—Oil, Gas, Combination Oil/Gas

For complete data send for Bulletin BE-400



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BOILER ENGINEERING & SUPPLY CO., INC.
Phoenixville, Pa.

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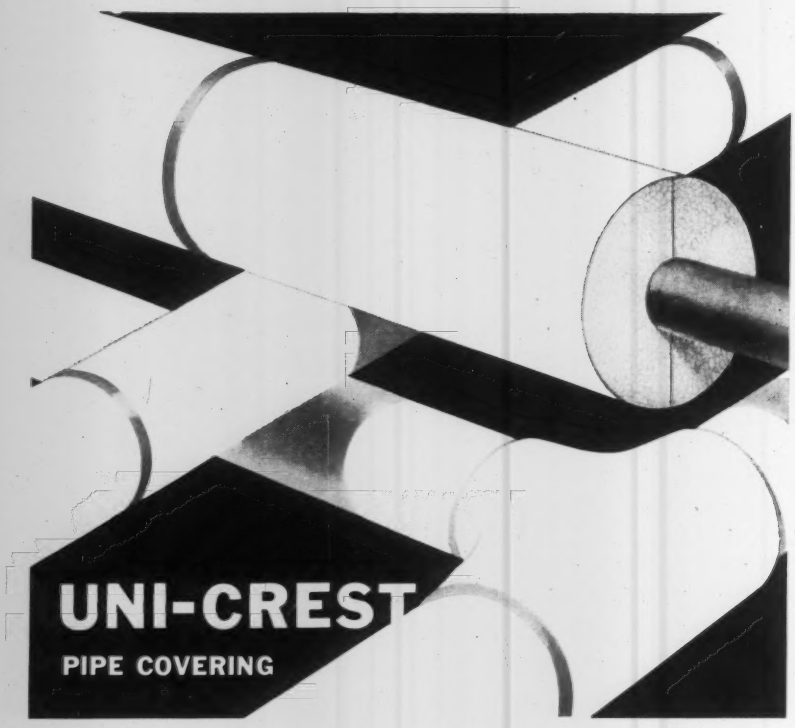
For free explanatory booklet and Directory of participating manufacturers, write to: Chief Engineer, Dept. H-501, Air-Conditioning and Refrigeration Institute, 1346 Connecticut Avenue, N.W., Washington, D.C.



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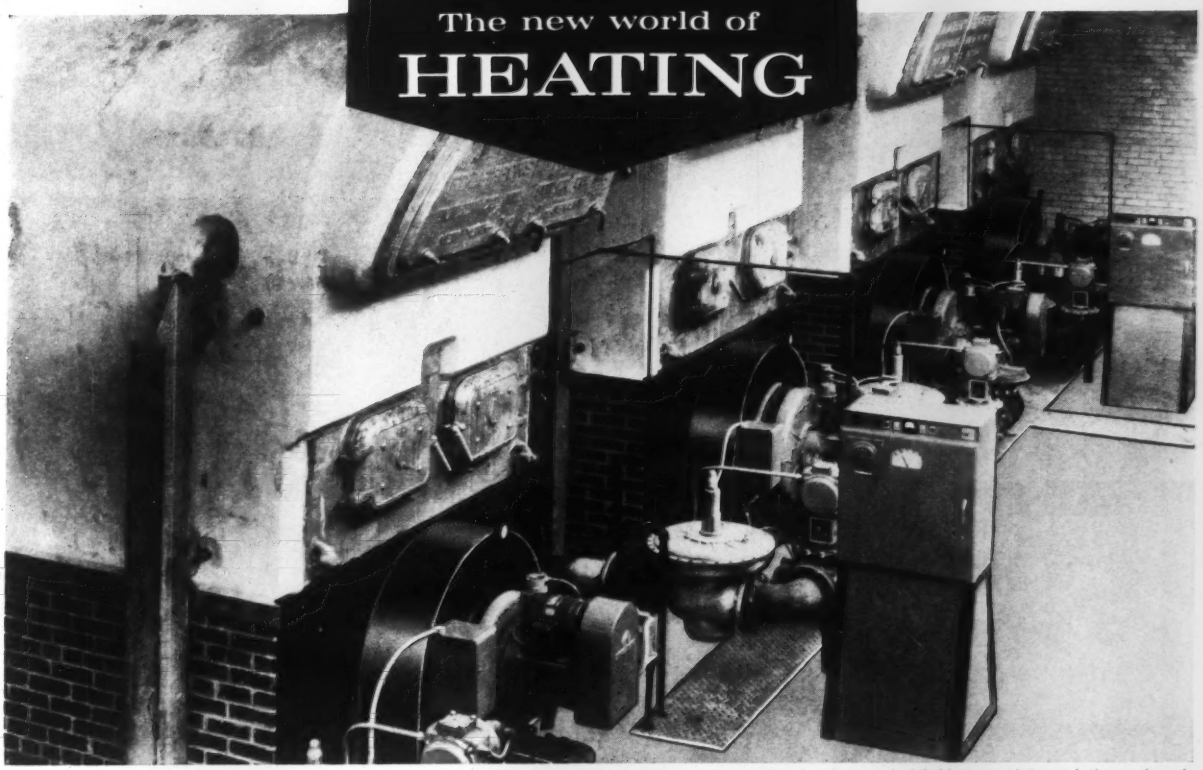

This Kansas high school heating plant uses four Iron Fireman dual-fuel burners with factory-built control panels.

Add high efficiency firing *without boiler alteration*

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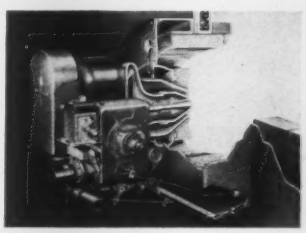

This cutaway shows how oil, gas and air are introduced into the combustion chamber through a single firing port. No checkered floor, firing arch or boiler pit. Flame is generated within a cone of air—no inefficient infusion of underfloor air.

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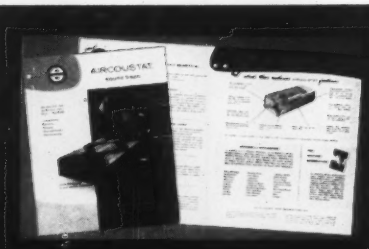
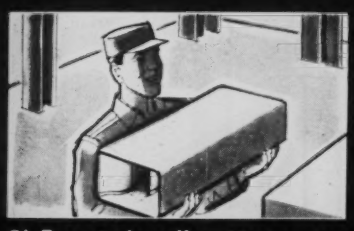
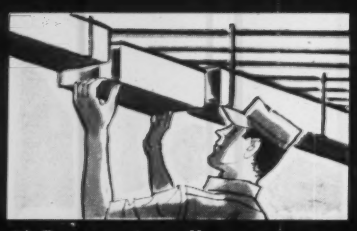


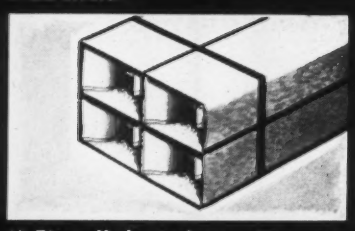
1) Easy to select—Just 3 steps to specify proper model. Save time, avoid errors.



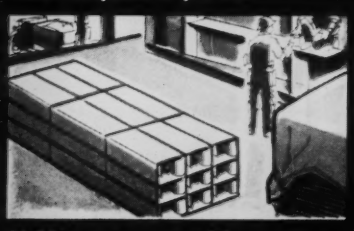
2) Easy to handle—No riggers or special equipment needed. Large units composed at job site.



3) Easy to install—Units are installed the same as ductwork. Units have 2" extensions.



4) Fits all duct sizes—Big units are easily assembled from small Aircoustat units.



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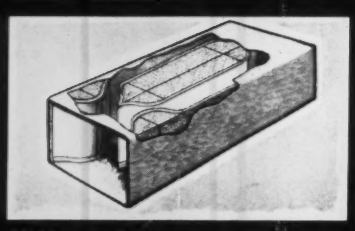

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- T-465 *Dual* Thermostats provide complete comfort whenever required, assure maximum fuel savings when rooms are not in use.
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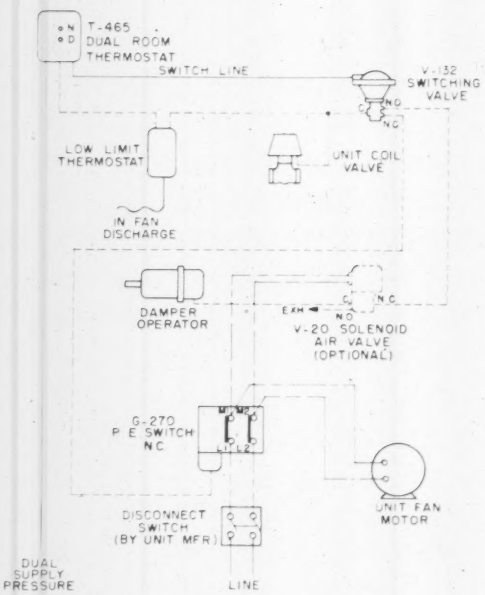
- Direct or reverse acting.

For complete information, send for Bulletin T-465. Johnson Service Company, Milwaukee 1, Wisconsin.

T-465 **Dual** Thermostat



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